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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS · · APRIL 3, 1961

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CAN MACHINES REALLY LEARN?... page 39
UNIVERSAL STANDARD FOR PRINTED WIRING
NEW MECHANISM STOPS SPIN OF ROTATING

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for your enthusiastic response to this announcement. Because it has been viewed as an important advance in valve development, we reprint this news for those who missed its first appearance.

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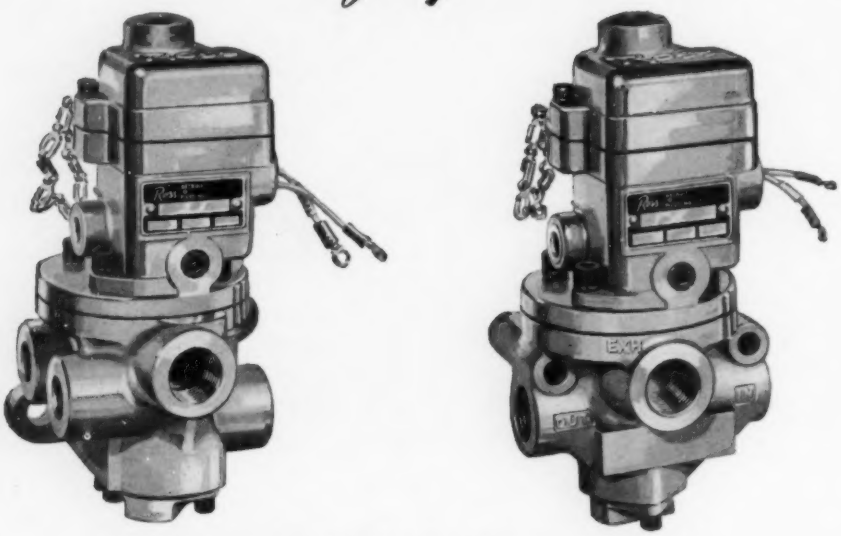

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McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS

April 3, 1961 Vol. 32, No. 14

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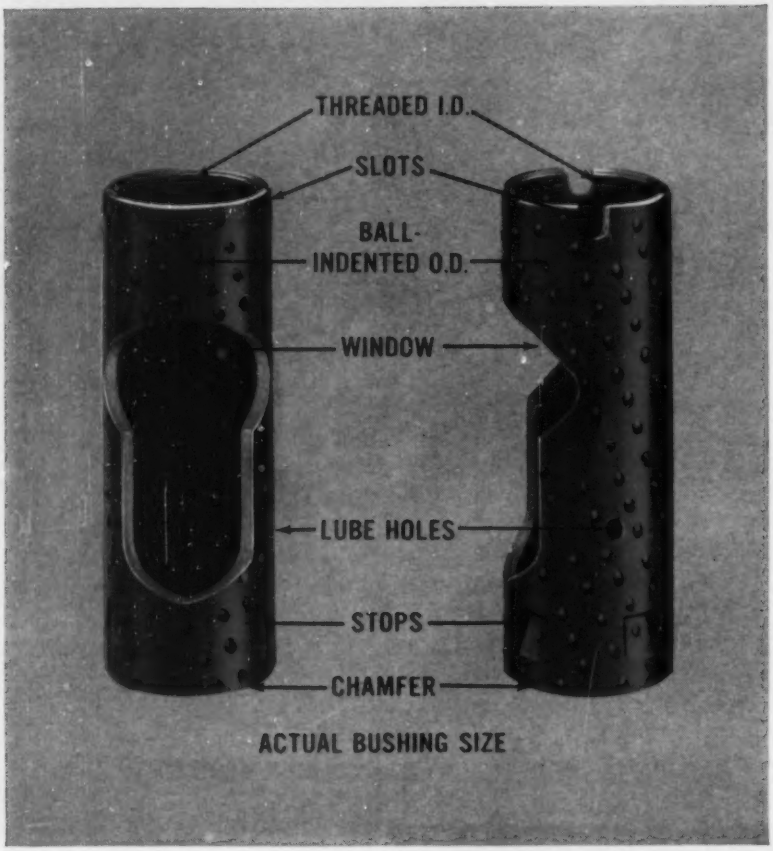
"EXOTIC" BUSHING MAKES NEW STEERING DESIGN COME TRUE



INSIDE-OUT BUSHING HELPS PUT NEW STEERING MECHANISM INTO PRODUCTION! To perfect a new steering mechanism, an automotive manufacturer required a linkage component. Designers tried making it of machined steel, then plastic . . . both materials failed. But the unusual bushing shown at left, with a number of features F-M engineers helped designers incorporate, solved the problem. It is bronze-on-steel, formed with the ball-indented bronze on the O.D. so the bushing can accommodate sliding motion within the mechanism. A large window makes insertion of a ball socket easy during assembly. Design of the bushing also includes: stops near one end to hold a disc . . . a threaded I.D. on the other with slots for a locking pin . . . holes that supply lubricant to the outer surface. For the F-M customer, all these built-in features helped accomplish this result—easy, efficient assembly and success with a new design.

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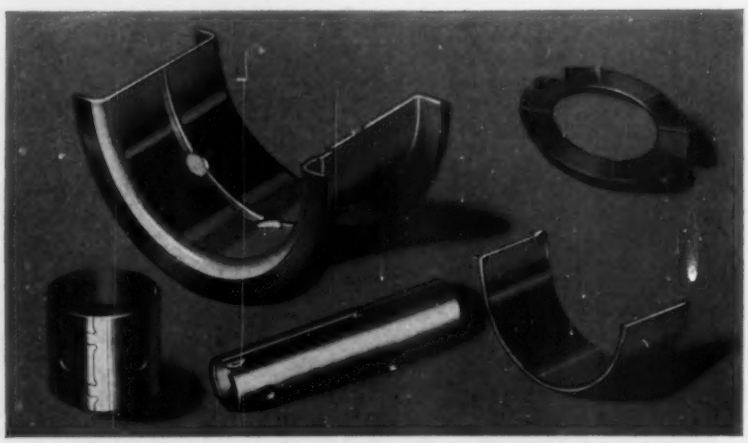

Additional information about bushings is provided in a Design Guide, published by F-M. Helpful literature is also available on sleeve bearings, thrust washers and spacer tubes. For your copies, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11043 Shoemaker, Detroit 13, Michigan.

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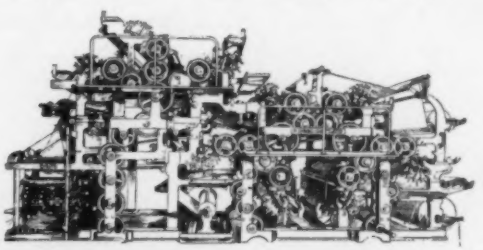
INTERESTING TO NOTE

On our cover . . . Ever since Gutenberg invented movable type, the pressure has been on to produce faster printing presses. For many years, the standard was a cast-iron monster who was fed single sheets. Type was locked up in a chase set on a reciprocating flat plate which passed first under ink rolls, then under impression rolls that carried the paper. Then, in relatively recent years, the rotary press was developed, at first for newspaper use. Here, the type is copied on a curved plate. This "stereotype" is mounted on a roll and prints on paper fed from a supply roll between the type roll and pressure roll. (PRODUCT ENGINEERING is printed on a flat-bed press, and, allowing for frequent cleaning and other servicing, actual production rate is perhaps 4000 impressions (a 16-page or 32-page "form" is printed at once) per hour. Now that our circulation is larger than 50,000, we will probably soon shift to a rotary, which averages 15,000 impressions per hour.)

Wall Street Journal, which must be produced daily at high speed, is actually printed at seven different plants for a daily run totaling 650,000 copies. The press shown on our cover, a Hoe Color-Matic—developed to combine high speed, easy adjustment and high-fidelity reproduction—is at the Chicopee Falls, Mass. plant of the *Wall Street Journal*. It consists of four Color-Matic units, a folder and four reels with automatic running-belt tensions and fully automatic web-splicing mechanism that can join ends of two rolls at full speed. It prints and folds upwards of 50,000 32-page newspapers per hour.

Gear trains incorporate spiral bevels, and are designed for minimum backlash (to avoid web breaks). The keyless gear-mounting arrangement was shown in our Mar 6 issue, p 51. Henry Dreyfuss did the design, which is unusual in that interlocking aluminum sections cover the ink motion and may be lowered to floor level for cleaning or general servicing.

Hoe has been a printing-press pioneer for more than two centuries. In 1845, the company's founder, Richard



M. Hoe, invented a 4-cylinder rotary press. His design quadrupled the speed of printing and ushered in the era of modern publishing. Three decades later, the first newspaper rotary-web perfecting press, with a rapid folding and

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A McGRAW-HILL PUBLICATION

April 3, 1961
Vol. 32, No. 14

Executive, Editorial, Circulation and Advertising Offices:
330 West 42nd St., New York 36, N. Y.
Telephone: LOngacre 4-3000
Teletype: TWX NY 1-1636
Cable Address: McGRAW-HILL, NY

PRODUCT ENGINEERING is published weekly by McGraw-Hill Publishing Company, Inc. James H. McGraw (1860-1948), founder. US subscription rates for individuals in the field of the publication, $3 per year, single copies 50 cents; Canadian subscription $5 per year; foreign $25 per year, payable in advance. Printed in Albany, NY; second-class postage paid at Albany, NY. Title ® registered at US Patent Office.

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gathering mechanism, was put on display at Philadelphia's famous Centennial Exhibition. In 1895, a sextuple press (shown in sketch, p 3) was built for the New York Journal. It was the largest press ever built up to that time, and printed both in black and color.

The First Gunsight

The need for accuracy in gears led some early designers to dream up some rather weird handle configurations. Even today, guns made for competitive shooting adopt a custom-made handgrip that would make the gunslingers of old stare in awe. Whether or not a fancy handle aids in improving the shooter's score is a question open for speculation.

Prior to 1600, guns, especially cannon, were most inaccurate. There was no method of sighting—the gunner merely aimed in the general direction of the target, fired the touchhole and stepped back. Then in 1622, an instrument maker and master armorer in Dresden, Christopher Trechsler, designed a gunsight embellished with a great deal of decorative engraving. Among other things, Trechsler is said to have been the first to make much use of fine micrometer screws for adjustment and leveling as well as measurement. The gunnery level was marked with scales showing the range of cannon balls of various types. Above the main indicator was a sighting device and a scale of degrees which enabled the artilleryman to make corrections for the throw of his gun.

—Benedict A Leerburger Jr

Mathematisch-physikalische Salon, Dresden

SIDELIGHTS

It isn't science fiction! Here is an abstract from *Nauka i zhizn'*, a Russian scientific publication.

"It is assumed that the brain radiation which is responsible for the distant transmission of thoughts occurs on wavelengths in the centimeter, millimeter, and micron ranges. The combined action of a number of radiation waves from the brain centers during the thinking process is capable of creating corresponding signals in the brain centers of a second person. Research now is being continued in Leningrad and Omsk."

This assumes mental telepathy is an accepted fact now under research. But the Russians have gone further. They say, "The possibility of creating a device for amplification of brain-radiation waves which could establish reliable communication between humans is indicated." So those of us who can't be taught to communicate telepathically will be provided with mind amplifiers—something we probably need anyhow.

Now they go one step further: "Generation of artificial waves similar to those produced by brain centers and designed to have a direct influence on the mental activity of people is also considered entirely possible." And this is mind control. Our only hope is that someone will simultaneously invent a mind shield.

We were a little surprised to see that the Yo-yo principle is now being applied to a despinning mechanism (see page 56). With a little research, we found that the Yo-yo, first used by children 25 years ago, was patterned after the "bandalore," a toy common in England around 1820. This antecedent of the Yo-yo, contained a coiled spring which caused it to bounce back, once thrown to the ground.

NEXT WEEK IN PRODUCT ENGINEERING

. . . How to Choose the Right Electrical Insulation

Equipment manufacturers now offer a wide range of materials. This simple method, based on two comprehensive tables, helps find the best one for your application.

. . . These 10 Guideposts to Low-cost Rubber Parts

Specifying an Elastomer for the First Time? You must be clear about the kind of product you want, or costs will mount.

. . . Hybrid Gas Bearings for Better Stability

New information on gas bearings shows how to combine hydrodynamic design parameters and minimum hydrostatic flow for stable operation.

. . . Must Engineers Also Be Idea Salesmen?

A company president and a market-development specialist take opposite points of view.

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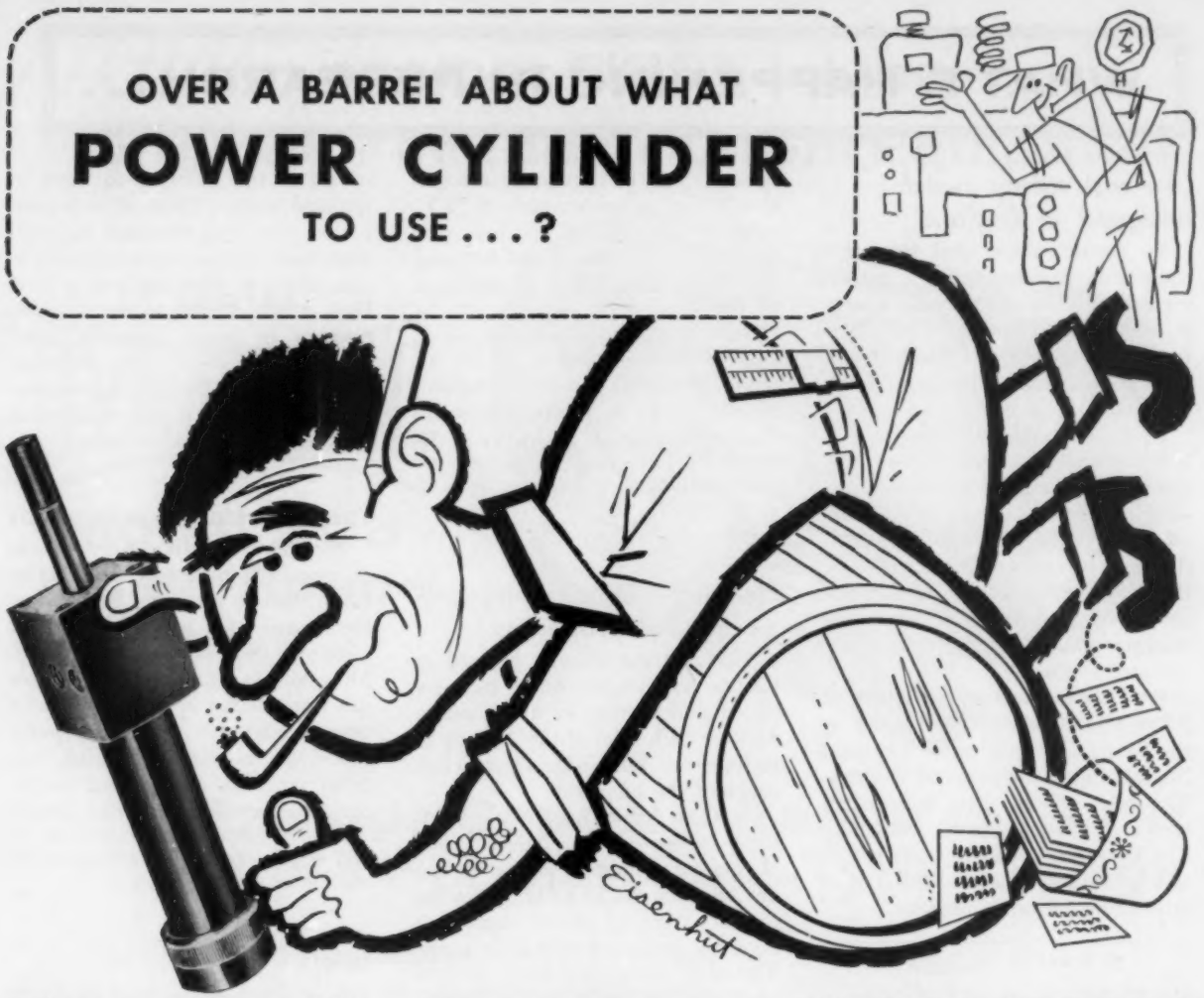

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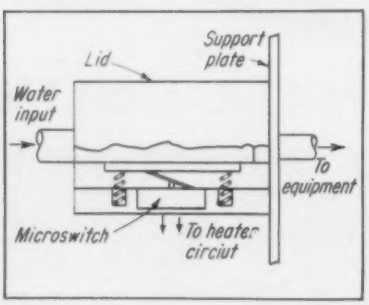
WHAT'S HAPPENING IN RESEARCH . . .

Low-cost safety switch designed in England

To protect watercooled laboratory equipment, British researchers are using the simple system diagramed here. It consists of a spring-loaded plate, impinging on the soft plastic water hose just in front of the unit being supplied.

If the water supply fails, or falls below a predetermined minimum, the spring compresses the hose and actuates the lever of the switch, cutting off the electrical supply to the heater. A pressure of about 20 psi will close the switch; and about 5 psi will open it—both figures are well below the working pressure of 40-45 lb generally used in the lab.

In a communication to *Review of Scientific Instruments*, R. Hawley of the King's College Dept of Electrical Engineering (University of Durham, England) admits that this system does not, like commercial units, indicate flow rate. But, he points out, it is a good deal less expensive and is satisfactory for most purposes.



Cold-rolled steels head for ultralow temperatures

New studies of cold-worked stainless (AISI 301 and 304L) indicate it can be safely used at temperatures to −320 F; and, if increased notch-sensitivity is taken into consideration, at −423 F.

Tests at NASA's Lewis Research Center indicate that best properties are attained with reductions on the order of 60%. Above that, elongation and sharp-notch tensile strength are markedly lowered.

A report (TND-592) on the tests, giving average mechanical properties of both steels, in thicknesses of 0.031 to 0.063 in. at temperatures of 75 F, −320 F, and −423 F, has been prepared by M. P. Hanson of LRC, and is available from NASA, Washington 25, DC.

Note: additional information on alloys for ultralow temperature use, including aluminum and alpha titanium, may be found in DMIC Memorandum #81, "Design Properties as Affected by Cryogenic Temperatures," being readied for publication by OTS as PB 161231.

Electrical changes pinpoint mechanical properties

The electrical changes induced in plastics and metals when they are placed under stress are being put to work on both sides of the Atlantic to increase our knowledge of materials structure and properties.

At Case Institute of Technology, the hysteresis pattern produced when plastics are strained in tension or flexure has been found to be distinctive for each type of plastic, and often even for variants within each group. The effect seems most easily observed when the test bar is bent in flexure. Charges of opposite polarity accumulate on the compression and tension faces, and for each plastic, the charge density is a characteristic function of the degree of straining.

This "micro-piezoelectric" effect has now been observed and plotted for nearly 60 materials, and a report on the tests was prepared by S. M. Skinner, now at Westinghouse, and E. L. Kern of the Air Force, for last week's ACS meeting.

The emission of electrons by metals when they are placed under stress is being used as a measure of torsion fatigue in a new series of British studies. This "exo-electron" emission has been found indicative of the surface changes that take place during fatigue; and it can be measured by the darkening of a photographic emulsion in contact with the metal surface.

According to A. H. Meleka and W. Barr of British Iron & Steel Research Assn., an increase in the density of negative-ion vacant lattice-sites takes place when the oxide film on the surface of the metals is damaged by torsional stress. These sites become centers that emit electrons; the electrons cause oxygen and water vapor in atmosphere to react together to form H_2O_2 which diffuses to the emulsion to form an image. Electron microscope examination after exposure shows the black lines on the emulsion correspond exactly to the slip-lines on the crystal surfaces of the metal.

Thoria tackles refractory jobs

For high-temperature lab work, and for processing molten metals and other hard-to-handle materials, thorium oxide ceramics are becoming commercially available. Among the suppliers: Morganite Inc in the US and Morgan Crucible Co in Britain. They're now ready to offer high-purity (99.9%) material, fabricated into tubes, crucibles, and the like (on order), to close tolerances. The material stands temperatures above 4700 F, and can be made impermeable without aid of a glassy phase.

briefs . . .

Life of aluminum-tin bearings can be doubled, Tin Research Institute (Britain) reports, by using continuously cast metal in place of chill-cast. Tests of solid aluminum—6% tin bearings show the continuously cast bearings last 100 hr or more at 4000 rpm under a 6600-psi load; while the life of chill-cast bearings is less than 50 hr.

Metal fibers can improve the thermal conductivity and resistance to thermal shock of such oxides as thoria, Argonne National Laboratory reports. But this type of "reinforcement" does not necessarily increase tensile strength. Indeed, fine cracks may develop which will reduce the over-all strength of the compact. However, ANL believes, the possibilities of adjusting the thermal characteristics by varying not only the type of fiber (molybdenum, zirconium, columbium, stainless steel)—but also the fiber content, diameter, and length—make such ceramic-metal fiber combinations well worth investigation.

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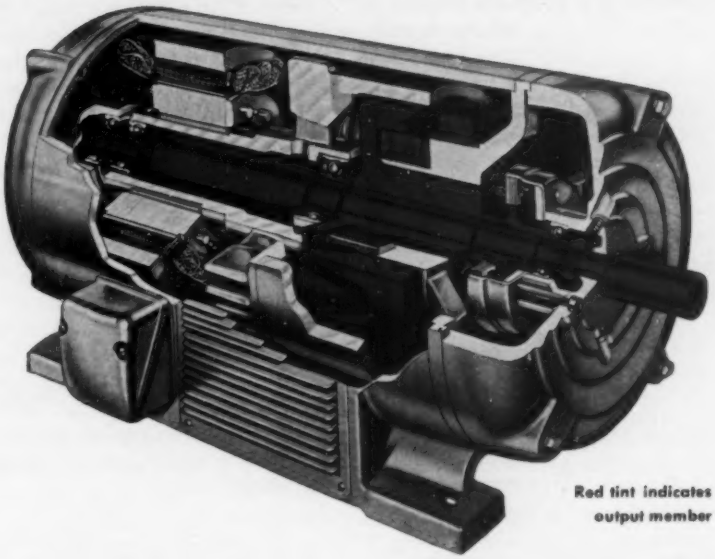

Red tint indicates output member

Extends Capacity Range to 15 HP in the Popular Quill-Type Design

The addition of the new model ACM-905 to the famous ACM-903 and ACM-904 lines of Dynamatic Ajusto-Spede Drives makes the desirable features of Dynamatic Quill-Type design available for many new applications.

Dynamatic Ajusto-Spede Drives provide controlled adjustable speed from an AC power source. Standard control features include on-off clutch control, infinite speed adjustment, constant speed regulation, and jogging. Any of a variety of special features may be easily and economically added to the standard control.

All Quill-Type models are available with either eddy-current, Dyna-torQ, or fail-safe brakes.

An Ajusto-Spede Drive, a control unit (either electron tube or transistorized magnetic amplifier), and a push-button station comprise a compact, easily installed, low-cost drive package.

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DEVELOPMENTS TO WATCH...

Conductive papers tested for cable wrapping

Electrical papers with controlled conductivity can now be produced in both sheet and strip form, Knowlton Brothers reports. First commercial production is a material with a resistance of approximately 1600 ohms per square, and a basis weight for 24 x 36 sheets of 45 lb to the 500-sheet count. First use of the material has been in communications equipment (facsimile machines), but tests indicate it may prove suitable for use as a conductive wrapping in applications where extremely high strength is not needed.

French try out dual dry-lube system

For ball bearings that must operate in a vacuum, Compagnie General de Radiologie (Paris) is testing a two-coat system which, it says, gives excellent performance.

The system involves deposition of a very thin layer of silver, lead, or mercury on high-speed steel balls, or on the bearing tracks, and then covering this layer with a coating of molybdenum or tungsten disulfide. The combination, Britain's *New Scientist* reports, gives considerably better service than either system alone, since the metal layer promotes adhesion of the sulfide and the sulfide protects the metal against corrosion and provides lubrication as well.

New ceramics promise high stability at high temperatures

Metal-modified oxides are a new and promising class of materials for refractory applications, Air Force researchers report. They've been investigating the mechanisms responsible for thermal and crystallographic stabilization of zirconia; and one approach to that problem, addition of metals (titanium, chomium, or zirconium itself) to ZrO_2, has opened the way to a whole new family of materials. According to Air Force Captain H. Rizzo, the new materials are far superior to conventional stabilized zirconia in thermal shock resistance, and have good strength and excellent refractory properties.

Also under study by Air Force ceramics researchers: silicon-boron-oxygen compositions. In a report to a recent AIME symposium, Capt Rizzo said these materials show considerable promise as lightweight, oxidation-resistant electrical and structural materials. They are stable in boiling water and stand temperatures at least to 2500 F in air. Electrical resistivity is on the order of 1×10^6 ohm-cm.

Thermocouples to monitor methane

A new kind of "Davy Lamp," to measure and record the concentration of methane gas in air, has been designed by Britain's Mining Research Establishment (National Coal Board) and is soon to be made commercially. (Photo here shows prototype model.)

Principle of operation is simple: Heat output of a butane flame is detected by a ring of thermocouples and displayed on a galvanometer-recorder. In the presence of methane, heat output increases, providing the desired indication. Butane supply must, of course, be maintained at a constant level with considerable precision, and a special regulator has been designed for the purpose.

FLAME METHANOMETER is new miner's lamp. It consists of butane (right) and recorder (left).

The unit will measure methane in concentrations of 0 to 3% with an accuracy of 0.1%, and produce a full-week record of mine conditions. Sigma Instrument Co Ltd, Hertfordshire, England will be the commercial producer.

These alloys show promise for difficult temperatures

The three temperature ranges that are the goals of Air Force metals research are −320 to 1200 F, 1800 to 2000 F, and 2000 F and above. The materials available for 1200 to 1800-F service are considered adequate for present-day needs. But, Air Force experts told a recent AIME Symposium, there have been no metals that could fully satisfy the requirements of the other three ranges.

Now, Wright Air Development Division's Materials Central reports, there is considerable hope for the 1800-F to 2000-F range. New wrought nickel alloys show a tensile strength of 50,000 psi at 1900 F.

Vanadium-base alloys also look good, though protective coatings are still needed.

Coming along, too, are oxidation-resistant titanium-based aluminum-columbium alloys. Some of these have a strength-to-weight ratio at 1800 F which "exceeds that of nickel base alloys."

There is a glimmer of hope even for the top range—above 2000 F. Most metals that might be used are difficult to fabricate, or need protection against oxidation even at moderate temperatures. But, says WADD, "Tantalum alloys are being developed which show promise of providing the only engineering metals in existence which are ductile down to −320 F and have strength properties comparable to molybdenum-base alloys up to 3000 F."

New instrument aligns fibers electrostatically

An instrument being developed to study natural fibers uses an electrostatic system to separate fibers and line them up on a microscope slide so they can be measured.

It consists simply of a high-voltage transformer (6000 to 12,000 volts rms), a sample chamber and indicating lamp, mounted on a chassis that is provided with a cover to protect the operator. In addition to this unit, the complete instrument has a special optical system and a photomultiplier counter.

Three groups cooperated in the design, under USDA sponsorship, and a report has been prepared by Special Instruments Laboratory, Knoxville, Tenn. SIL emphasizes, though, that the system is still in the prototype stage and more work needs to be done to prepare it for general commercial use.

Microminiaturization faces heat barrier

Heat dissipation is becoming as much a problem in microelectronics as it was with electron tubes. The reason: high power density which packs so many units in so little space that even though the heat generation from each unit is tiny, the buildup is considerable. The situation is further complicated by the fact that microminiature circuits are normally fabricated with intimate contact between the components, so temperature conditions of each component are interrelated. The internally dissipated heat must be transferred through devices rather than through inert structures.

The magnitude of the problem is reflected in the number of papers on the subject scheduled for delivery at technical meetings this year. H. C. Kammerer of IBM discussed one aspect of the problem at the ASME Aviation meeting, Gaylon Kornfuehrer of Texas Instruments will outline heat-dissipation problems in transistor operation at the SWIRECO meeting later this month. There will be others later on, discussing such approaches as use of pulse logic, which requires only discrete voltage pulses rather than a continuous flow of current as do dc systems; lower signal levels; solid circuits; and high-temperature components.

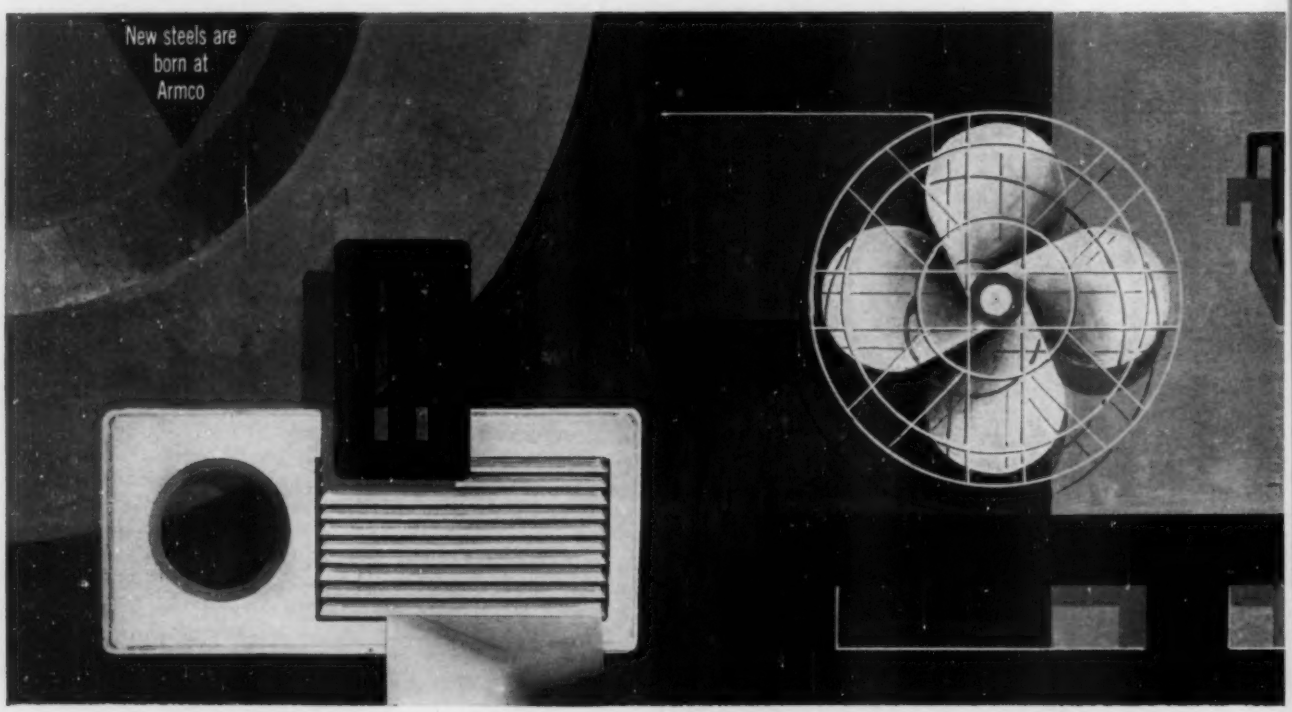
Future looks dim for atom-process heat

Nuclear reactors will not soon compete with conventional systems for low-temperature process heat, says F. K. Pittman, AEC Director of Reactor Development. Though once considered an extremely promising application for small reactors, this one has just about been written off on a cost basis.

Even the small central-station nuclear plants look less promising than they used to, Pittman says. For "at least the next several years, they will not be able, except under highly specialized conditions, to compete with fossil-fueled powerplants."

AEC is not writing small reactors off entirely, though. Work is continuing on a low-temperature process-heat reactor for a water desalinization plant, and, of course, small powerplants for the military are still being developed. —ARG

Now, Two Armco Enameling Metals Expand Design Potential of Porcelain Enamel



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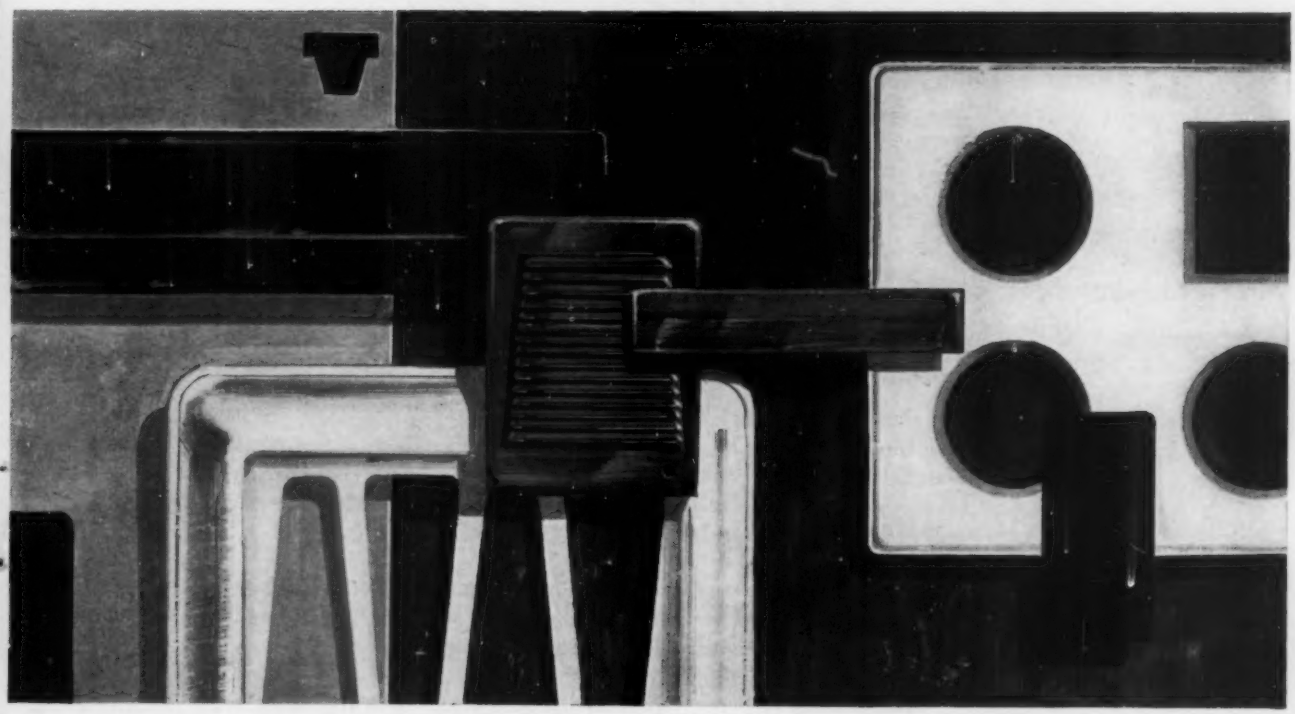


ARMCO **Armco Division**

CIRCLE 11 ON READER SERVICE CARD

FROM WASHINGTON . . .

What Post Office wants—mechanization minus gimmicks

Postmaster General Day has invited industry to design equipment that will speed the postal service. He is quite specific about what is needed:

- **A simple, durable machine that will read, face and sort mail by chemical or electronic operation.**
- **Flexible, reliable and variable stamp-dispensing equipment.**
- **A simple, reliable basic sorting machine that will at least separate mail by States.**
- **Mailboxes that will stack letters as they are dropped in.**
- **Equipment that reliably sorts packages without Rube Goldberg installations and squads of hovering mechanics.**

Discussing equipment needs, Day says: "We have no interest in gimmicks or gadgets. **We have no interest in blue sky projects full of 'ifs' for the millenium of another century.** We do have millions of pieces of mail to move every day. We need help to do it better."

If private industry is interested, he adds, it should send its "research men to us, to find out our requirements—and come back to us with prototypes of fresh new mechanized answers to our questions, promising enough to justify the investment of public moneys in further development."

Day says he drew up his list of needed equipment after consultation with some of the nation's larger mailers. So the machines would have a much bigger market than the Post Office itself; they would be usable by "thousands" of offices where mail is important.

Air Force centralizes R & D management

The Air Force has begun a massive organizational revamping of its multibillion dollar research & development setup to simplify and centralize management.

This is to be worked out through a new "Air Force Systems Command" which will incorporate the bulk of ARDC and the weapon-system production functions of the Air Materiel Command. Both ARDC and AMC are being abolished as separate entities. A new "Air Force Logistics Command" will be created to take over general-supply management tasks.

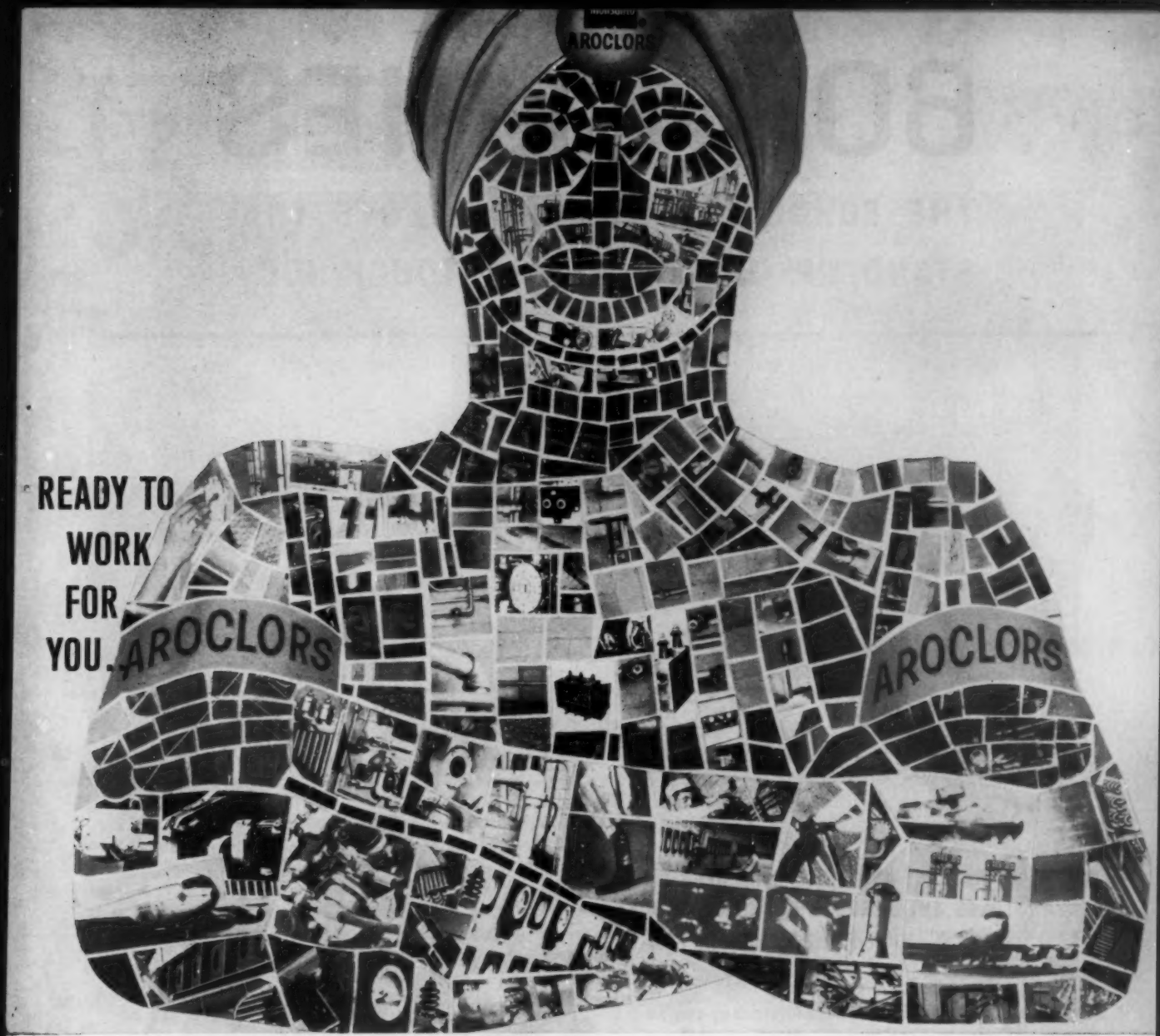
Reorganization reflects the view of many Air Force planners that the R & D and production phases of ICBM projects, space systems, advanced aircraft and so on are no longer clearly distinguishable.

In the past, management authority has shifted from ARDC to AMC when a project such as Atlas moved from one phase to another. Now a contractor will be dealing with one procurement agency, whatever the status of his project.

The new systems command will be made up of four divisions: Ballistics Systems, Space Systems, Aeronautical Systems and Electronic Systems. The new command will be headed by Lt Gen B. A. Schriever.

A new "Office of Aerospace Research" will be set up, reporting directly to the Air Force's Chief of Staff. The agency will come out of ARDC and will be similar in function to the Office of Naval Research.

CIRCLE 13 ON READER SERVICE CARD→



"GENIE" OF A THOUSAND AND ONE ENGINEERING FEATS

- **AT YOUR CALL IN MANY PHYSICAL FORMS:** light, mobile oily liquids/viscous sirupy liquids and resins/solid resins and crystals.

- **VIRTUALLY INDESTRUCTIBLE:** resist breakdown from heat and mechanical stress/resist burning/rebuff electricity with their high resistivity/refuse to oxidize, volatilize, hydrolyze or otherwise react with highly reactive chemicals.

- **"EDUCATED" TO PERFORM HUNDREDS OF ENGINEERING TASKS:** *heat-transfer mediums* for uniform, firesafe, controlled "cooking" heat to 600°F. in economical nonpressurized systems; *coolant-dielectrics* for "fireproof" transformers and other electrical equipme *impregnants* in fixed-paper capacitors for air conditioners, furnaces, washers and other home appliances; *insulating seal* cotton and asbestos wraps, carbon resistors, electrical terminals and bushings; *lubricants* for vacuum diffusion pumps, foundry car bearings, journal boxes, precision grinding; *expansion mediums* in bellows control, thermostats and regulat *"tack" agents* for fire-resistant wiping cloths, dedusting reactive chemicals, dust catchers on air filters, and other "d *vapor suppressants* for volatile insecticides, *binders* for pigments and dyes, *bonding agents* in adhesive compounds, *imp*

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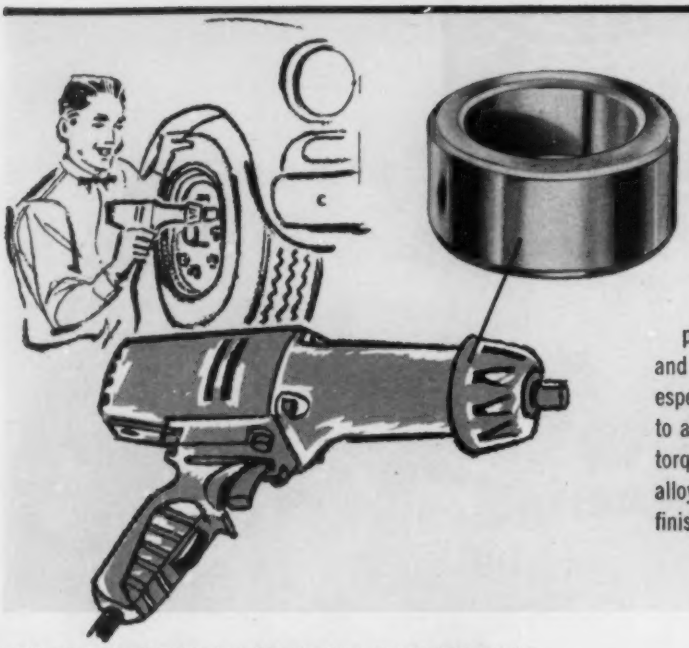

600 ALLOY NOSE BEARING WITHSTANDS THE PUNISHING SHOCK LOADS OF AN IMPACT WRENCH

This heavy-duty impact wrench takes the rigorous punishment of hard industrial use right on the nose . . . and right on the 600 Series nose bearing. This bearing was especially chosen by the manufacturer because of its ability to absorb a range of 1600 to 1800 impacts per minute at a torque of from 0 to 250 foot pounds. By specifying 600 bearing alloy, the manufacturer gets superior performance from his finished product.

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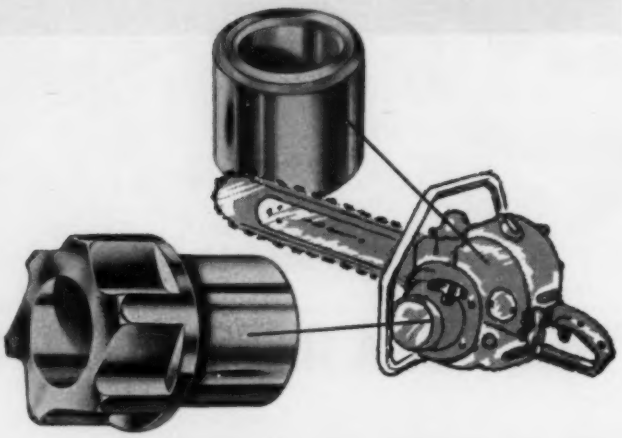
Professional woodcutters give chain saws a rough time for hours on end, all year round, and these rugged saws must be built to take punishment. With chain speeds up to 3000 feet per minute, the ratchet and drive gear bearings, for example, must have a very high strength, hardness and good resistance to wear with minimum lubrication. That's why 600 Series Alloy was specified for both parts . . . the ratchet is a forging and the bearing was produced from 600 Series rod.



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326

THE ENGINEERING WEEK

EISENACHER WARTBURG passenger car shown by East Germany resembles a 1950 Chevrolet.

Leipzig Fair Stresses Less Bizarre Design by Reds

BONN—The key display that the Communist nations trotted out this year for their annual industrial showcase—the Leipzig Fair in East Germany—was the order book. Their goal was sales, not propaganda, during this 10-day show which occupied 3¼ million sq ft, and featured exhibitors from 51 countries.

By and large, the nationalized factories and their engineers from behind the Iron Curtain concentrated on showing solid, if not sensational, advancement in automation, standardization and appearance design. In times past, they've yielded to the temptation of spicing their exhibits with new products and designs that wouldn't—and, indeed, couldn't—reach a production line. For example: the well-publicized Chinese passenger car, Red Flag, displayed to the accompaniment of resounding hoopla at the 1960 Leipzig Fair, has never been seen again.

This year, China and the East European nations were at Leipzig in an effort to demonstrate the reliability and maturity of their engineering as evidenced by their expanding industries. This sales drive was aimed chiefly in a westerly direction.

Though a good deal of trading went on in the Red camp, the Communists regard the Fair as their best opportunity all year to do business with nations outside the Iron Curtain—especially with the underdeveloped countries of Africa and Asia. In seeking this business, Communist design and engineering in everything from cars to machine tools continued to show an increasingly Western flavor.

Most striking example of this was provided by the handful of automobiles the East Europeans had on display. The Russians and Yugoslavs showed small, aircooled, rear-engined passenger cars—dead ringers for the Fiat 600. The Soviet's Zaparochez has a 23-hp (SAE), 4-cyl engine with a top speed of 56 mph, and fuel economy of about 43 mi-per-gal. The Yugoslav Zastova 600-D has a 4-cyl engine delivering 29 hp (SAE), achieving a max speed of 70 mph and a fuel economy of 40 mi per gal. The Czechs offered a dolled-up Touring Sports model version of the Skoda Octavia with 2 carburetors and a 53-hp (SAE) engine, a max speed of nearly 100 mph, a fuel economy of 30 mi per gal., and unmistakably British lines. In addition, the latest model of East Germany's Eisenacher Wartburg duplicates the short 1950 Chevy in appearance.

Heaviest stress laid by the Communists was on machine tools. This dovetails with their intention, announced last year, to build the Leipzig Fair into a major international machine-tool show to rival any staged by the West. The Czechs are particularly keen on this since machinery production represents nearly 30% of their industrial output, and they rank third in world production. They hope to overtake West Germany and the US by 1970.

EAST GERMANS FAVOR BUILDING BLOCKS

However, it was East Germany that dominated the machine-tool section with 130 machines from 25 factories on display. Machines ranged in size from the small lathes to elephantine presses. Some 30 were being shown for the first time. This collection demonstrated that the East Germans are committed to the building-block concept which they adopted two years ago. In addition, they're linking up more standard tools via low-cost, simple conveying and handling attachments to produce versatile transfer lines for low- and middle-quantity production runs. Over 80% of East German tools this year would be classified as fully or semiautomatic, an increase of 5% over last year.

The East Germans are using a lot

of punched-card programming systems, especially for lathes and boring machines. However, they're steering almost entirely clear of tape-control systems. Non-cutting machines were prominently displayed by the East Germans. Among these: a high-speed crank forging press which is outfitted with automatic feeding attachment and a high-frequency electrical heating plant capable of delivering 2500 tons of compression force. This machine was linked to a plate-slab and billet shearer to form a short-link line that turns out drop stampings of steel pipe flanges at a rate of 720 pieces per hr.

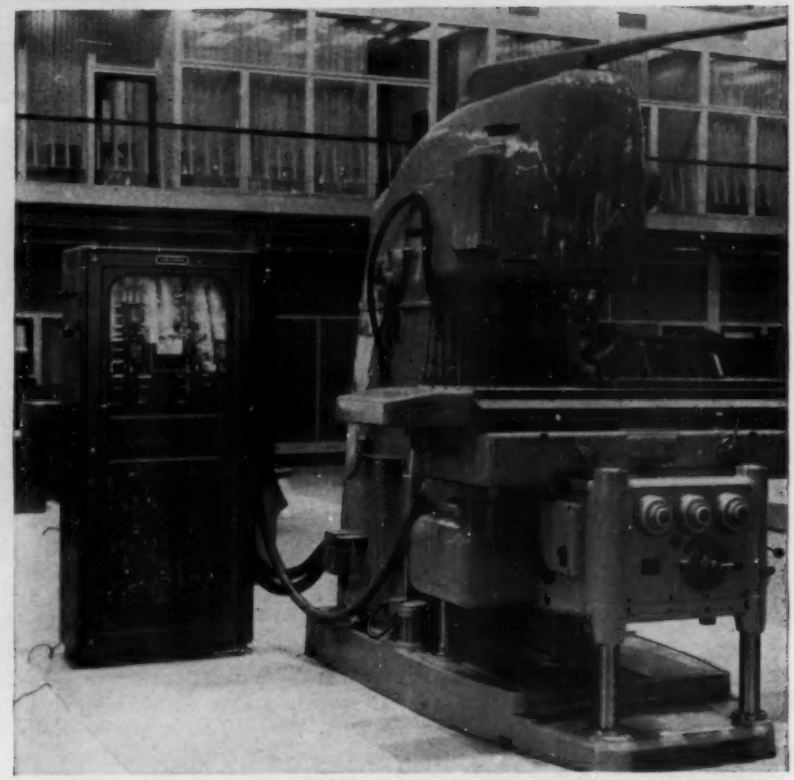
A horizontal sliding wire-drawing machine took molybdenum wire via 8 drawings from a max dia of 0.5 mm down to a min dia of 0.4 mm. A 40-ton crank press linked with 4 automatic thread-bulging machines produced preserve jar lids.

The Soviet Union, with about 30 machines on display and Czechoslovakia with nearly 50 machines, both exhibited tape-controlled machine tools. The Soviet machines included a vertical lathe for machining shaft centers and a vertical knee-type miller with copying attachment for a variety of high-precision milling jobs. The Czechs used a dekatron computer to replace stopdogs for setting the limits of table travel cn their tape-controlled, vertical, knee-type miller.

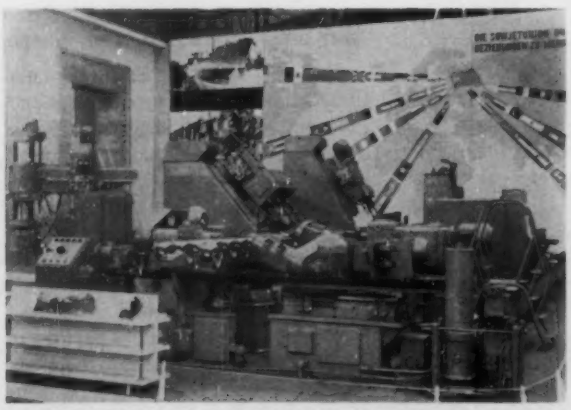
The USSR also showed a semi-automatic, 9-station transfer line for turning out automobile crankshaft bearing plates at a rate of 65 per hr, and a fully automatic 6-station transfer line for producing car motor-oil filter housings at a rate of one a minute.

The Czechs showed a new vertical chucking lathe to turn heavy flange-shape parts; it is programmed for as many as 36 individual operations with a combination of punched cards and stop drums.

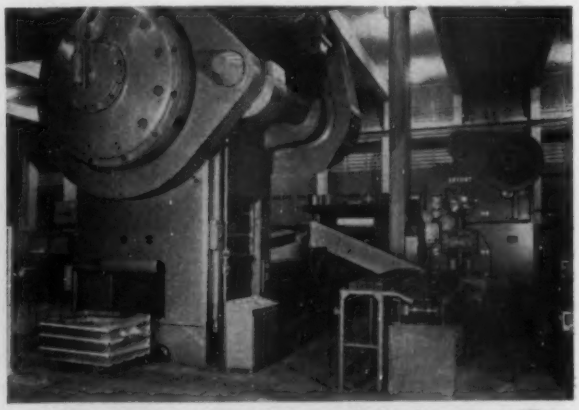
Red China proudly displayed 12 machine tools, which, unfortunately,



CZECHOSLOVAKIA exhibited this tape-controlled, knee-type vertical milling machine (Type FB50). At left is a dekatron computer used to replace stopdogs in the setting of limits of table travel. Optical scales on all sides are scanned by several photoelectric detectors which transmit pulses to computer. Pulses are counted and compared with readings on 35-mm photographic film punched tape.



SOVIET UNION displayed this transfer line (Type IL93) consisting of six machines for producing car motor-oil filter housings at a rate of one per min. Coupled together are a miller, preliminary and deep-boring machine and reamer, a groove chamfer, double-ended machine for countersinking rivet holes, deburrer, rotary-indexing automatic for tapping. Machine is outfitted with 13 milling and boring units, 35 spindles and 21 electric motors.



EAST GERMANY offered this crank forging press (Type PKXW 2500) which delivers compression pressure up to 2500 tons. It is fitted with automatic feeding attachment and high-frequency electrical heating plant. Here the forging press is linked with slab shears and billet shears (Type ScPK 500) delivering a shearing force of 500 tons. This short link line can produce drop stampings of steel pipe flanges at a rate of 720 pieces per hr.

everyone had seen last year at Leipzig, including the centerless internal grinder which attracted so much attention. Peiping also displayed heavy electrical power equipment, radios, TV sets and fabrics. However, as with the other Iron Curtain nations, such items as cars, medical instruments, consumer goods and agricultural machinery took a back seat.

For all their efforts to make the Leipzig Fair into a major international machine-tool marketplace, the Communists got a disappointing response from the West. Admittedly, Western participation increased; i.e., more steel from Britain, chemical plants from Italy, toys from Japan, sugar from Cuba and coffee from Brazil; but in the significant area of machine tools, fewer Western manufacturers turned out this year, and those that did booked less space.

This lack of enthusiasm stems from the fact that very little machine-tool business is transacted at the show. Says Dowding & Doll, who brought eight machines to Leipzig, including the US-licensed, British-built Weidemann punch press, "We're not interested in getting into barter deals with the Communists. And since they don't have much hard currency, bartering is all we can expect."

West Germany, however, made a strong showing. Some 35 of its firms displayed about 100 machines. Though down slightly from last year, the fall-off was excused by the brief interruption of East-West German trade flow last year. For West Germany, Leipzig is a gateway to the east where their products and manufacturing representatives are known.

As usual, no US machinery builder participated at the Fair. However, a group of American steel fabricators (including National Steel Corp and Babcock & Wilcox) appeared, marking the first time any US firm has made a personal appearance.

Though the Communists claim that $1 billion worth of business was transacted between East and West during the Fair—East Germany says it alone bought $125 million from the West and, in turn, sold another $200 million worth of goods to the West—observers point out that much of this business was conducted with underdeveloped countries like UAR, Ghana, India and Indonesia.

—Pete Forbath, Bonn Bureau

New Detroit Compacts Budding for Next Year's Blooming

DETROIT—Because US-made compacts now account for nearly 34% of the new car market, each auto maker is feverishly readying versions and variations for 1962. Of course, spring has helped to spark new models.

Pontiac is now offering a 2-door Tempest with or without a sports car interior (below). Falcon has introduced a deluxe trim package for its 2-door which it calls a "Baby T-bird" but which is really competing with Corvair's fast-selling (40% of production) Monza models.

Lancer and Valiant have already announced hardtop models, and chances are somebody will offer a convertible to eliminate Lark's and Rambler's exclusive grip on this style.

However, by the next model year, the cycle may be complete. Already there are two new Fords, code-named Canadian X and Canadian Y, that will fill the gap between current Falcons and Fords, and Comets and Mercurys, respectively. These cars will be powered by a 200-cu in., V-8, cast iron engine with a 115-in. wheelbase, and will weigh about 300 lb.

Chevrolet is up with the pack as usual. On the docket for 1962 is a car code-named H-35 which is very close to the dimensions of the Ford newcomers. However, it will be powered by an all-new, watercooled, inline 6-cyl engine. A 4-cyl version of this powerplant has also been designed. It will utilize many interchangeable reciprocating parts and is slated for a baby compact Chevrolet has in reserve should Ford decide to market its Cardinal in the US.

The much-discussed Cardinal is a 99.5-in.-wheelbase car, powered by a V-4 engine connected to a front-wheel drive. There may actually be three versions of this: one for the domestic market, another assembled in England for the Commonwealth market, and a third assembled in Germany for the common market.

Studebaker, which once planned a new model in this Volkswagen-size category, has temporarily shelved the idea. Development work on its 4-cyl engine, though, is continuing with the Lark in mind. Like the Pontiac Tempest, this would be the current V-8 block sliced in half lengthwise.

Most interesting of all the newcomers are Ford's and Chevrolet's 115-in.-wheelbase models. Actually, these are not much smaller than the standard-size low-price car of a few years back. They will be similar, both have abandoned wrapped-around windshields and dual headlights.

The medium-price model field, which has already lost DeSoto, will remain pretty much the same in design. No new engines are slated for 1962, and the same basic body shells will be used by all makes.

On the upper price levels, there is concern only for the future of Imperial as a separate design. Chrysler is closing the plant which makes Imperials on July 1, and it is unlikely that further production of this chassis model can be integrated with the unitized lines of other plants.

—Don MacDonald Detroit Bureau

Corrosion Stress-cracks Compel Reactor Shutdown

WASHINGTON—Uncertainty over reliability of 17-4-PH stainless steel nuclear reactor components is assuming major proportions at the Atomic Energy Commission. AEC's Division of Licensing and Regulation, in its most recent of several safety actions stemming from discovery of 17-4-PH materials defects in boiling-water

continued on page 20

PONTIAC's NEW 2-door Tempest comes with or without a sport's car interior.

How to design sales power

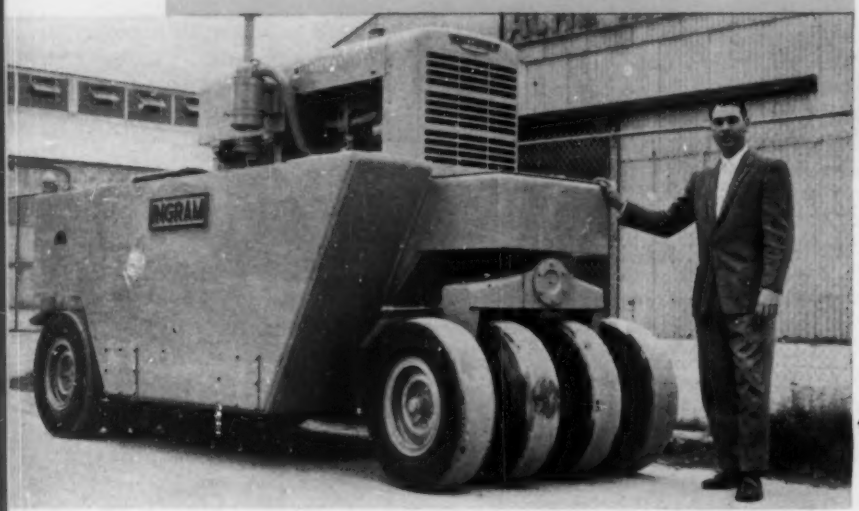
HERE'S WHY ACME IRON WORKS

THE ENGINEER SAYS...

"It's easy to design equipment using International engines and transmissions. Accessory mountings are no problem, and International's technical experts are eager to help with special requirements."

—Marvin Quay, Chief Engineer, Acme Iron Works, San Antonio, Texas

Chief Engineer Quay is an enthusiastic International booster, though not the first to specify IH power. For most of the company's 35 years in business, International engines have been standard equipment.



Vice President and General Manager Bryant Ingram with new 10-ton pneumatic roller, powered by International UC-221 engine. The roller has five speeds forward and reverse, mounts five rear tires on oscillating axles.

Acme management is pleased with Engineer Quay's power choice. Mr. Ingram, General Manager of Acme, says, "We have installed thousands of International engines in our products and never had a complaint. They produce the right power, and have a long service life. Records show that they need fewer repairs. No matter where we may ship a roller, engine parts can be supplied quickly by International outlets in every part of the country."

An increasing number of designers and manufacturers are solving heavy-job power problems with International engines. When you specify IH power you simplify engine installation, service and repair. Should your design encounter problems, International engineers will help you work out a practical solution. Check your own requirements against the solid, sensible facts stated by engineers who prefer IH power. When all points are considered, the choice is International.

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THE SALESMAN SAYS...

"People like International engines, and most of our prospects are already familiar with the extensive IH parts and service organization."

—E. M. Anderson, Vice President, Sales, Acme Iron Works, San Antonio, Texas

THE CUSTOMER SAYS...

"Our operation demands top performance and 100% availability. Experience with eight IH-powered Ingram Rollers has shown them to be most reliable. They give us steady operation, year after year, with only an annual inspection."

—Travis Jenkins, General Manager and V. P. C. H. Allison, Inc., San Antonio, Texas

Acme salesmen sell their equipment by going over the product's features, point by point. When they come to the engine, they seldom have to say more than, "It's an International!" This, more than anything else, tells the prospect that the machine is quick-starting, economical to operate, and easy to service. It's the part you don't have to sell, because prospects are already familiar with International economy and dependability, as well as the world-wide parts and service organization. This pre-sold power package adds another plus feature to your sales story. Thousands of users report the outstanding performance of International engines. From crop sprayers in Florida to construction equipment in Alaska, the word is that IH-powered machines start faster, work better, last longer. Investigate International soon, and find out how easy it is to design Sales Power into your products.

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A COMPLETE POWER PACKAGE

CIRCLE 19 ON READER SERVICE CARD

continued from page 17

reactors, has refused General Electric permission to operate its reactor of this BW type at Vallecitos, Calif.

GE advised the commission on Feb 8 that the Vallecitos reactor had been shut down to determine whether it had the same sort of difficulties experienced last Nov by the Dresden BWR operated by Commonwealth Edison. Dresden had cracking problems in its control-rod blades and control-rod drive index tubes.

Four long corrosion-stress cracks were detected in one control-rod shaft at a point outside the Vallecitos reactor vessel. In a safety review sent to AEC, GE admitted that failure of control-rod shafts above the seals could allow a control rod to be driven out of the core by steam pressure.

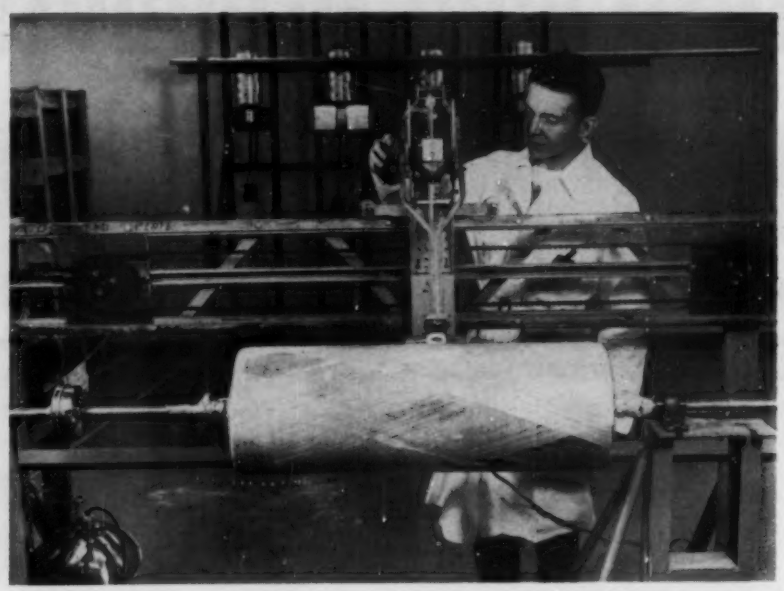
GE advised that the shafts would be replaced by type-304 stainless steel parts and that four lower grid 17-4-PH holddown studs would be provided with type-304 backup supports. All other 17-4-PH parts would be replaced with austenitic stainless.

But even with these changes, the Vallecitos reactor will probably not now be able to proceed with commercial tests. A recent AEC order, reads:

"The recent discovery of cracks in precipitation-hardened stainless steel components in the control-rod drive systems of the Commonwealth Edison reactor at Dresden, the experimental boiling-water reactor at Argonne National Laboratory, and the Vallecitos BWR has indicated the need for a detailed review of the design, fabrication procedures, and inspection of such components to determine their suitability for reactor service. Accordingly, General Electric is hereby ordered to submit to the commission the information listed below and not to resume operation of the Vallecitos BWR until authorized by the commission after evaluation of such data.

The material to be submitted by GE must cover all material and component fabrication for precipitation-hardened stainless steel items in the reactor, including assembly sectional drawings and a full discussion of the basis for GE's belief that design changes and material substitutions in its BWR are adequate. An independent lab will also be asked by AEC to evaluate 17-4-PH problems and suggested remedies. ■

Lab Makes $20,000 Winder for $3500



A filament-winding machine for making fiberglass solid-propellant rocket motor casings has been constructed at a cost of $3500 in its Sunnyvale, Calif. research lab, says United Technology Corp. UTC says similar machines on the market cost $20,000. Before winding filament, a mold is made in the shape of a hollow cylinder (or mandrel) with a closed-end configuration. Water-soluble plaster is cast into the mold and cured in an oven after removal of the mold. After curing, the plaster mandrel is sprayed with a white rubber material which serves as the rocket motor's liner. The mandrel is then placed on the UTC filament-winding machine for the actual winding process. Four spools of fiberglass rope are positioned in a tension device which provides constant pull on rope going into the casing (each rope strand contains 120 glass threads, each of which consists of 80 filaments). Ropes are impregnated with an epoxy resin, then traversed over the length of the cylindrical mandrel in a helical winding pattern. Heat lamps keep the resin in liquid form during the winding process. After winding, water is squirted inside the casing, dissolving the water-soluble mandrel. Casing is then ready for filling with solid propellant.

Job Mart Flourishes Next Door to IRE Show

NEW YORK—A byproduct of the annual meeting of the Institute of Radio Engineers is a central marketplace for job-hunting engineers and their counterparts, the job recruiters. Here, for the second year in a row, personnel men from 50 US industrial firms interviewed some 2500 engineers, scientists and technicians who flirted with new jobs while attending the IRE show.

The meeting-hiring place is administered by Careers Inc, a personnel agency specializing in placement of technical people, and is located in hotel suites across the street from the Coliseum where the IRE show was staged.

Besides saving lots of time, the job center offers corporate clients the added benefit of reducing recruiting costs by more than half. It now can cost a company up to $2000 per man for conventional recruiting.

According to William A. Douglass, president of Careers Inc, no fees are required. "The engineer merely fills out a single application form which can bring him into contact with scores of employers. However, the engineer and recruiter meet only if both parties are interested in each other. Also, an applicant's identity is kept secret until he decides to accept an invitation for a personal interview."

Douglass reported that every conceivable variety of engineer has visited the center, that there has been a comparatively large percentage of PhD's applying, that more than half of those registering have had more than 11 years' experience, and that a majority of applicants are in the $11,000-15,000 salary bracket. ■

Chicago's Automated Mail Challenges Ingenuity of Design Engineers

Recently, the Chicago Local of the Post Office Clerks Union charged that automation in that city's main post office "had destroyed mail and was endangering the lives, limbs and health of postal workers" (PE—March 20, p 17). To check these charges, Product Engineering sent its news bureau reporter Bruce Cross to look over the "Mail Flo" setup. His report: only "danger to life and limb" in the system is that employees might bump their heads against low-hanging conveyors. But he did find challenges to design engineering . . .

CHICAGO—The "Mail Flo" system here, consisting of 26 miles of conveyors, is located on the 4th and 9th floors of the main post office, with another system to be installed on the 8th floor this summer. The present setup cost $6 million.

One safety hazard that did cause postal authorities considerable concern was the 3rd-class-mail system, which does not require fast handling. Often, a string of its mail trays, made of plastic and measuring 4 x 14 x 28 in., would be held up on the conveyor system. However, power remained in the system. This meant that additional trays would create a pile-up, eventually buckling trays and dropping them to the floor below. This is known in conveyor-system circles as the "accumulation bugaboo."

To counter this hazard, Post Office engineers decided to take the power away from the rollers—which are similar to roller skate wheels. Result is that now, a rubber paddle moving along beneath the trays engages every other tray and pushes it along. If the string of trays is stopped, the paddles bend back and slip by; thus a string of trays more than 300 ft long can be held without danger. Safety screens have been installed as an additional precaution.

A similar accumulation problem on the 9th floor was solved by installing a new kind of conveyor system. Called an accumulating pressure conveyor (APC) and manufactured by Rapid Standard Co of Milwaukee, it is no more expensive than the paddle type and permits an indefinitely long string of trays to be held back. Heart of the system is a mechanical pressure-sensing device.

Here's how it works: If two trays move along a conveyor, weight of the first actuates a linkage which disconnects any driving force from the tray that follows. This is done by lowering the driving wheels beneath the following tray so that no power can be applied to it.

Linkage action is extended in a kind of chain reaction back along the entire length of the string of trays (similar to the block system used by railroads) so that until the trays are moved again, a distance of 12 in. automatically separates each tray. When an entire string of trays is held back, only the lead tray receives power and this can be held by an arm. A mere 3 oz of pressure can hold one tray—or a 1000 trays.

Big problem with the paddle conveyor was noise. The paddles are attached to 2-wheel trucks which run in a steel channel track. Initially, the postal engineers ran steel wheels in the tracks. Thousands of these wheels combined to create an unbearably loud chorus. It took 3 weeks for a 4-man crew to replace the steel wheels with hard rubber wheels.

Another problem has been the declinator—a device which carries trays vertically between floors (inclined conveyors would have taken up too much space). Each floor has conveyors which can inject trays into this system for delivery to another floor.

To operate these transfer mechanisms, power is taken directly from the big chains which carry all the load. When a tray is to be transferred, a dog is engaged with the main chain, providing power for the transfer mechanisms. This sudden engagement produces an undesirable amount of shock and vibration—trays have even fallen off the declinator. A contractor modification will seek to provide each transfer mechanism with its own coordinated source of power. **—Bruce Cross, Chicago News Bureau**

Rival Tires Pass Gruelling 15,000-mi Test

DEDHAM, MASS.—Good-quality tires are tough, durable and safe even under severe driving conditions, Fabric Research Laboratories (FRL) reports after 15,000 mi of testing nylon and viscose cord tires. FRL says there is no consistent pattern of failure, and that, as earlier research has shown (*PE*—Apr 4 '60, p 9), the cords themselves degrade—it's the tire assembly that breaks down.

Good news for the viscose industry, sponsor of the test, was the almost insignificant difference in strength retained by nylon and rayon tire cord. After 15,000 miles, the nylon retained 85% of the original strength and the Tyrex (viscose) 82%. Both figures are far higher than that considered necessary for safe operation.

Furthermore, says FRL, the strength losses that did occur happened before the tires were really broken in—at less than 3000 mi—and after that, cord strength losses were minor, regardless of the mileage.

After 10,000 mi of driving in Manhattan the cords were almost as strong as they were after 20,000 mi. And at all mileages, they were strong enough to meet generally accepted standards of tire safety. Impact strengths also remained relatively high.

The laboratory reports also that "cord fatigue is not a factor in tire failure. Rather, it's a system problem —a problem of construction and adhesion—not really a problem of tire cord strength." ■

UK Refrigerator-makers Cold to Competition

LONDON—British refrigerator manufacturers are insisting that their government order all imported refrigerators clearly identified as foreign goods. And the UK may just do that.

Manufacturers here complain that foreign standards for computing refrigerator capacity, shelf space, temperature and tolerance are loose compared to standards enforced in the UK. This flexibility, particularly in France and West Germany, enables foreign manufacturers to make claims for their products which British firms can't match. ■

NEW McGILL® CAGEROL®

deliver up to 10 times the life of ordinary needle

You can confidently specify new CAGEROL cage type needle roller bearings to increase the expected life of your bearing applications, up to 10 times — as compared with end-guided needle bearings. This new McGill bearing will easily carry the usual needle roller bearing loads where shaft misalignment and speeds exceed the capabilities of ordinary needle bearings.

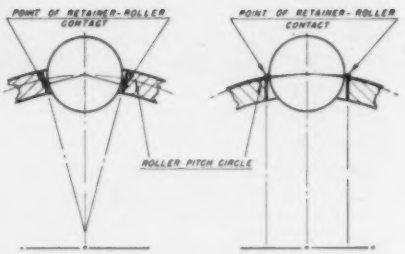
In this new McGill design a precision tubular cage spaces and locates specially heat treated crowned rollers. They are positively controlled to insure concentricity and prevent heat increases at higher speeds. The black oxide finish on retainers provides corrosion protection and stores lubricant in the porous surfaces. Friction is further reduced.

MR series CAGEROL bearings are interchangeable dimensionally with all heavy duty needle bearings. They are available with or without separable inner races.

Built especially for the tougher applications CAGEROL bearings feature many design and construction advantages. Put these new bearings and the McGill engineering department to work for you. Ask for recommendations.

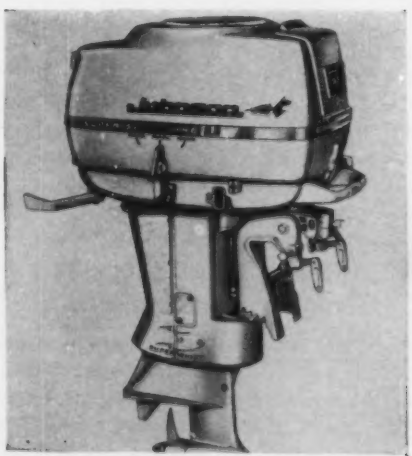
ROLLERS CROWNED TO PREVENT "END LOADING"

Rollers are crowned to relieve ends and prevent "end loading." Under load, stress is distributed uniformly throughout the length of the roller raceway. This prevents metal fatigue and premature bearing failure. Flat roller ends fully engage integral race shoulders for maximum possible support. Specially heat treated high carbon-chrome SAE 52100 steel insures long roller life.

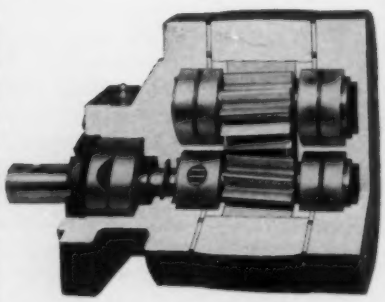


TAPERED RETAINER POCKETS GIVE BALANCED SUPPORT TO ROLLERS

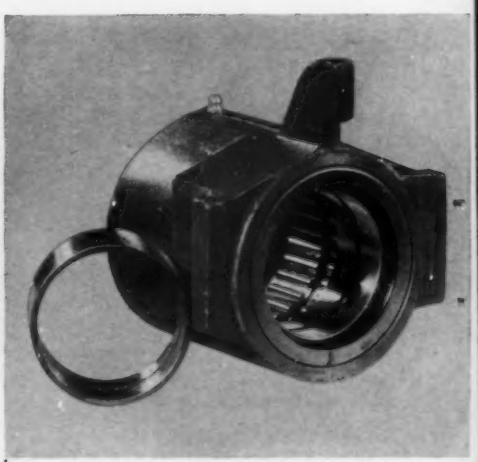
Proper roller guidance is assured by tapered retainer pockets with retainer OD selected to fall outside the roller pitch circle. This establishes roller and crossbar contact on a concentric plane just below center. The McGill design insures balanced roller support and eliminates corner wear from edge loading of straight pocket walls where the retainer OD and pitch circle are coincident. The cage is supported by the outer race flanges.



CAGEROL bearings are being used by JOHNSON MOTORS in the upper journal positions of their 35 horsepower motors. Shown is the JOHNSON 35 h.p. SUPER SEA HORSE.



McGill CAGEROL bearings support the internal gears which rotate and operate under high pressure in COMMERCIAL SHEARING & STAMPING COMPANY oil hydraulic pumps and motors.

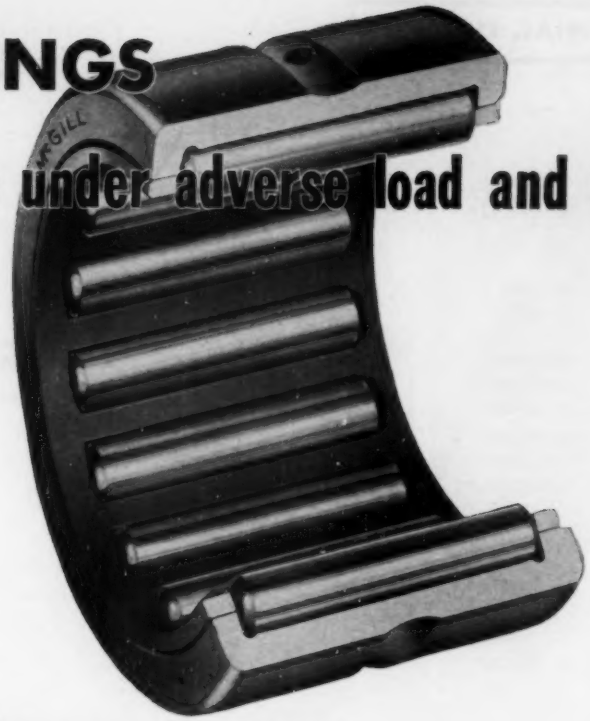


B & B INDUSTRIES selected CAGEROL Bearings to permit increased roll pressures and reduced maintenance in their first anti-friction Calender Stack bearing units for Pickers in the textile industry.

WRITE TODAY FOR FREE McGILL BEARING CATALOG No. 52-A for complete data on McGILL GUIDEROL, CAMROL, MULTIROL and CAGEROL BEARINGS.

BEARINGS

bearings under adverse load and misalignment.

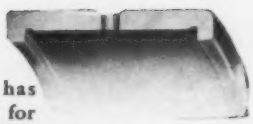


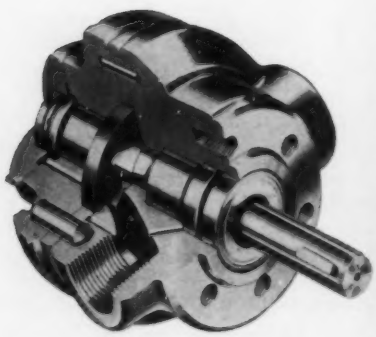
RETAINER BUILT FOR ACCURACY AND MINIMUM FRICTION

Simultaneously punched pockets in a continuous retainer assure the accuracy of race and roller alignment. The black ferrous oxide retainer finish absorbs and retains lubrication. The resulting low friction coefficient provides excellent performance at high speed.

INTEGRAL RACE FLANGES SUPPORT CAGE

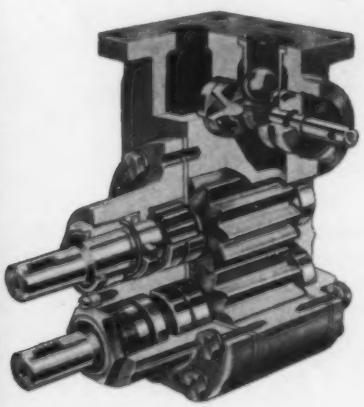
The SAE 52100 steel outer race has optimum hardness and surface finish for best performance. It is of one-piece, double-flanged construction. Flanges are integral with the race and support the cage around its circumference.





DOUBLE A PRODUCTS COMPANY has incorporated the advantages of the new CAGEROL bearing into their GEROTOR hydraulic pumps.

CAGEROL bearings have been selected for a variety of applications in HY-HOE back hoes manufactured by HYDRAULIC MACHINERY COMPANY.



Spur gear support requirements in ANTHONY COMPANY heavy duty hydraulic pumps are now being met by CAGEROL bearings.

engineered electrical products

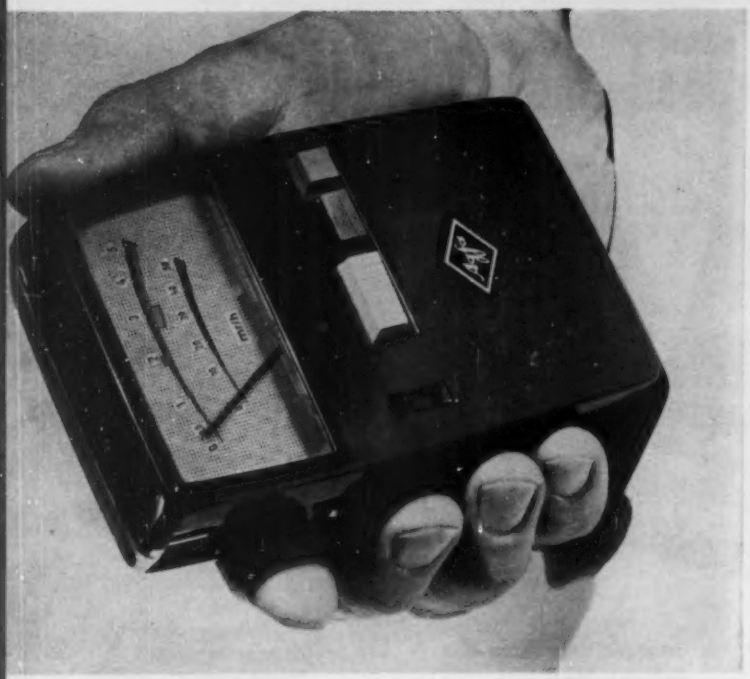
McGILL®

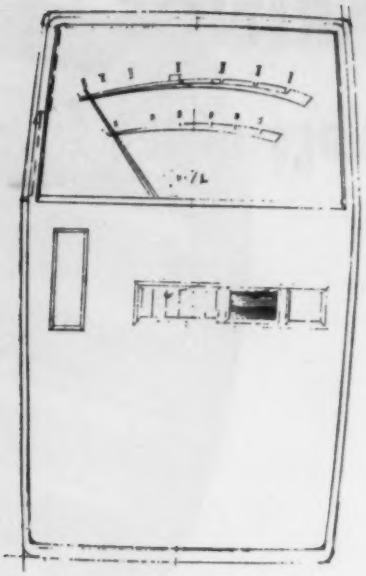
precision needle roller bearings

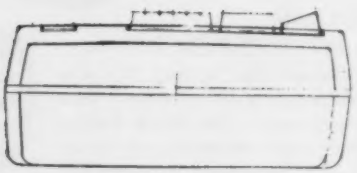
MULTIROL-GUIDEROL-CAMROL-CAGEROL

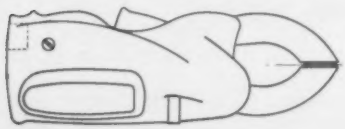
McGILL MANUFACTURING CO., INC., Bearing Division
201 North Lafayette Street, Valparaiso, Indiana

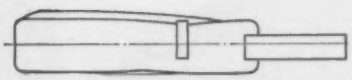
CIRCLE 23 ON READER SERVICE CARD 23





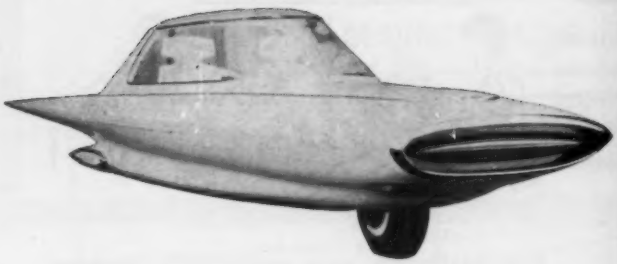


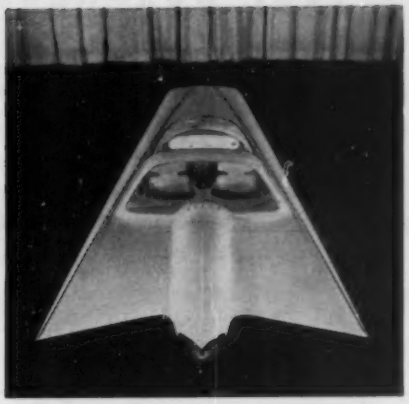


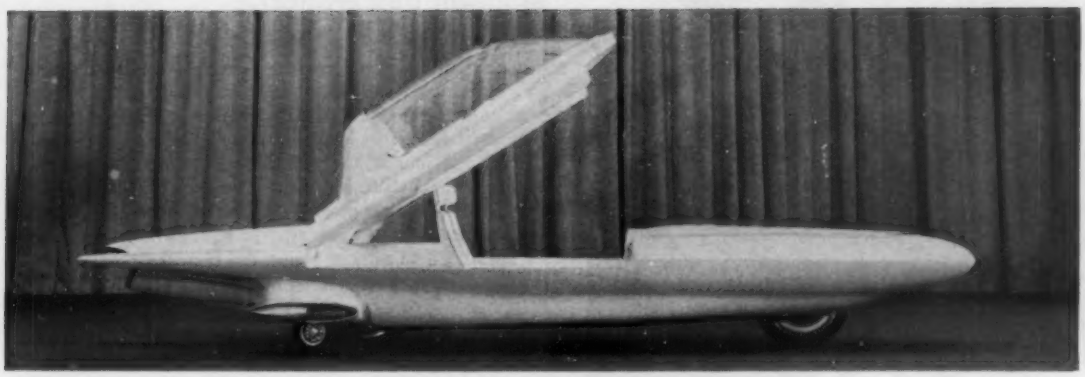


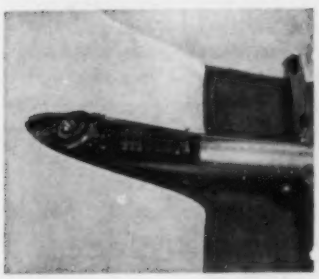
Transistor-equipped dosimeter, top, provides indication of beta-gamma radiation in milliroentgens per hour, both visually and acoustically. Visual signals are given on two-colored scale (arc over which needle travels widens and a secondary red strip emphasizes arc sector, indicating dangerous radiation levels) and by flashing light—flashes become more frequent as higher radiation counts are encountered. Audible signals are available through a plug-in earphone, or by connecting meter to an ordinary radio or record player. Dosimeter is operated by rechargeable batteries. Sliding panel just above index finger in photo slides down to reveal radiation window. Measurement ranges of 0 to 5 and 0 to 50 mr/h are selected by depressing colored buttons. Compact case is divided so that top half lifts off for servicing. Sides are tapered and body is free from protuberances, giving operator a secure grasp, and making it easy to slip meter in and out of pocket. By Goertz Industrial Design Inc, New York City, for Agfa, West Germany.

Clamp-on volt ammeter designed in England and marketed here by Ferranti Electric Inc, Plainview, NY, consists of a current transformer whose output is rectified and fed into an ammeter. The self-aligning, neoprene-covered clamp arms are opened by depressing the trigger. The meter has five black scales for current readings from 0 to 4, 12, 40, 120 or 400 amps ac, in conductors up to 1 in. dia; and three red scales for voltage readings from 0 to 150, 300, or 750 v ac. A knot turned by operator's thumb swings the desired black scale into view in dial window. Voltage readings are obtained with accessory leads and clips, which plug into bottom of ammeter. Scale-selecting thumbwheel is shaped so that scales can change only one at a time, eliminating hairline adjustment. Tool and instrument elements have been combined into a unit for one-hand operation—in fact, our left-handed reporter felt that contouring for right hand may prove too tight.









Delta-shaped automobile supposed to run on two gyroscope-stabilized wheels is the latest product of Detroit members of the prolific design-for-publicity school. A full-scale, nonoperative model of the "Gyron" (over-all length, 209 in.; height, 44.85 in.; width, 86 in.; road clearance, 6½ in.) is being exhibited by Ford Motor Co in New York's International Auto Show this week. Actually, there is a historical precedent for this proposal—James Scripps Booth introduced his two-wheeled, gyro-stabilized "Bi-Autogo" more than 50 years ago, but found that in those days of no power steering it was almost impossible to return the steering wheel to straight ahead after turning. Ford's design calls for power steering, of course, actuated by a steering dial rather than a wheel, with separate rings for steering and speed control. Accelerators and brake buttons are incorporated in the foot bars, which permit driving from either seat. A computer housed in the nose permits driver to "program" trips on nonstop expressways, by pushing buttons that would feed in distance to destination, starting time, desired speed and arrival time. Performance, in relation to selected program, would be displayed on screen directly below windshield, which would also serve as infrared "snooperscope," to picture road conditions ahead despite fog, darkness or other difficult conditions. Seats are contoured and support heads, backs and upper legs. Small support wheels would be retracted when car is in motion. Ford says, ". . . cost alone makes it impractical for production, either now or in the foreseeable future." Amen. . . . and why not make the next designed-for-publicity auto reflect the wealth of available data on operator vision, control delineation and safety. JK

Are your bookkeepers better equipped than your engineers or draftsmen?

You certainly want your bookkeeping department to have the latest equipment to maintain accuracy and output—but your highly trained professional engineers or draftsmen need today's tools, too—for the high production efficiency you've a right to expect.

Your draftsmen, your productivity, deserve new Hamilton space- and time-saving equipment from Bruning

Inefficient, obsolete equipment in your drafting department may be *stealing dollars* from you every working day! Top professional draftsmen work better, work smarter, make fewer errors when they use premium-quality Hamilton equipment. Boosts morale, too! Watch *your* top men respond to the professional challenge of smart modern Hamilton units engineered to fit your needs. Learn why thousands of firms have selected Hamilton year after year . . . call our designers for planning help without obligation, of course.

HAMILTON L-CONTOUR TABLE Sturdy, counter-balanced drawing surface travels full 20"—permitting frequent position change, greatly reducing fatigue—quickly adjusted to individual requirements for each individual job. Board completely stable in all positions, horizontal to vertical. Modular construction permits arrangements to suit specific needs—right or left reference desk position optional. Ruggedly made, durably finished with long-life drawing and reference surfaces.

Hamilton Unit System Files
Provide full protection, accessibility, and classification for all materials to be filed. Occupy minimum floor space.

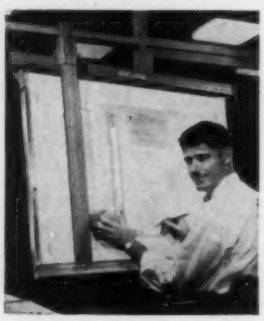
Hamilton Auto-Shift Table
Built-in mechanism adjusts board to individual height and slope requirements, provides full accessibility, reduces errors.

Hamilton CL 100 Drafting Table
Conserves dollars, yet rugged canted-leg design provides modern styling and convenience with long-term durability.

Put draftsmen in a "position" to do better, faster work!

Bruning's all-new Neoglide drafters literally help draftsmen straighten up and do faster, better work.* They provide complete maneuverability on any board at any angle without adjustment! Reinforced U-beam construction assures rigidity, strength, and accuracy. Resistance-free movement of vertical beam and hidden counterweight provide fast "floating" action. Touch-control protractor head gives automatic, pinpoint angle selection.

*Study of 300 draftsmen showed 35% savings in drawing time—1/5 the backaches—on vertical or near vertical boards.



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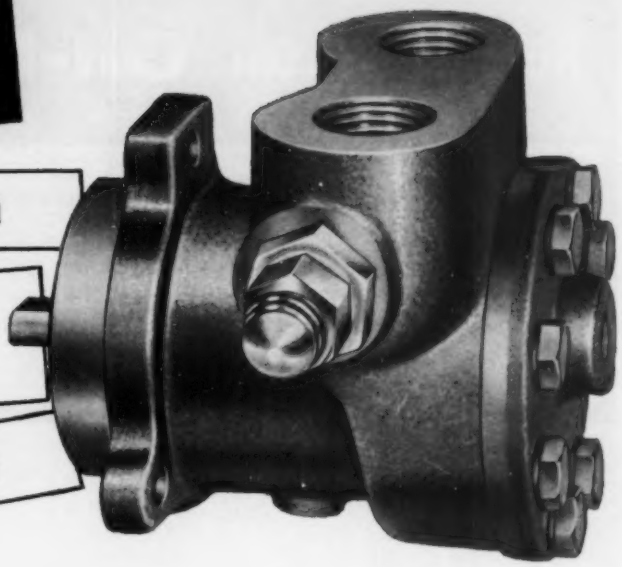
CHARLES BRUNING CO., INC.
1800 CENTRAL RD., MT. PROSPECT, ILLINOIS

NOW

Compact design

Complete mounting interchangeability

Built-in relief valves



on TUTHILL small industrial pumps

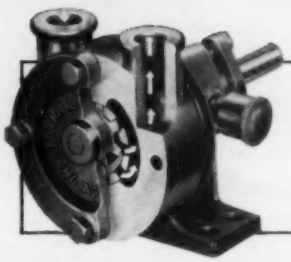
Now a new design—Series LPFV—gives you even greater flexibility with Tuthill small industrial pumps . . . the industry standard for dependable operation for many years.

Complete interchangeability allows the use of any one of five different sizes in the series on the same mounting arrangement. Capacities range from 20 to 360 gallons per hour, at pressures up to 500 psi. Normally provided for 1800 RPM, 3600 RPM speeds are permissible in most cases. And a built-in relief valve is now offered as optional equipment on all LPF models.

Compactness, an outstanding characteristic of all Tuthill pumps, is particularly exemplified in the new model LPFV with its shorter mounting hub. It is also available in close coupled motor-pump combinations for applications where space and weight are at a premium.

The newly designed model LPFV incorporates the performance-tested operating characteristics of Tuthill's internal gear construction described at right. In thousands of applications . . . in hydraulics, lubricating, transfer, circulating and other services . . . Tuthill internal gear pumps have established enviable records for reliability and quiet operation.

Over 700 models of Tuthill internal gear pumps are available to provide one especially suited to your application. These include stripped models for built-in applications, cartridge pumps, reversible models . . . a host of specialized pumps for each individual service. Mail the coupon today.



TUTHILL internal gear pumping principle

In Tuthill internal gear pumps, proven in 30 years of operation, there are only two moving parts. The principle is based upon the use of a rotor, idler gear and a crescent shape partition cast integral with the cover. Power applied to the rotor is transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the outside diameter of the rotor is sealed by the crescent. As the pump starts the teeth come out of mesh increasing the volume. This creates a partial vacuum drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and the rotor and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port.

Tuthill Pump Company
963 East 95th Street
Chicago 19, Illinois

☐ Please forward information on LPF series
☐ Please have your representative call

Name_____ Title_____

Company_____

Address_____

City_____ State_____

Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities From 1 to 200 GPM; for Pressures to 1500 PSI; speeds to 3600 RPM.

PUMPS FOR YOUR PURPOSE

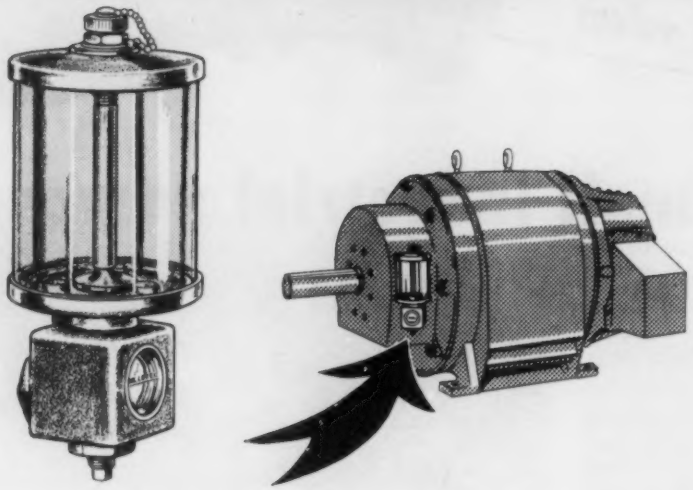
TUTHILL PUMP COMPANY

963 East 95th Street, Chicago 19, Illinois

New Ideas From Oil-Rite

. . . to solve your lubrication problems

Are you looking for low cost Oilers — automatic lubricating systems — special lubricators, systems or components — *ways to reduce costs?* You will find the answer in the Oil-Rite line — complete with engineering service.



HERE'S A SAMPLE

A manufacturer of large electric motors wanted visual proof of proper oil level within a device which continuously replenishes oil as used by bearings. Oil-Rite suggested this lubricator with a large sight in base for easy visual check of oil level. It also includes a top filler cap — an exclusive Oil-Rite feature on all constant level lubricators.

Consult us on your requirements for lubricating equipment. Specific information will be furnished promptly to help you select suitable equipment, adapted for your individual application. Benefit from our *25 years of accumulated knowledge and skill* in this field. There is no obligation.

Write for the complete Oil-Rite catalog.

Oil Cups • Dispensers
Oiling Systems • Valves
Oil Gages • Chain Oilers

Oil-Rite CORPORATION
2382 Waldo Boulevard • Manitowoc, Wisconsin

READER TO EDITOR

To Preach or Not

To the Editor:

Your Feb 20 (p 63) editorial titled "Is Your Morality Showing?" is before me.

1. I respectfully suggest that you pick a hasty retreat to your particular area of competence.

2. If you feel compelled to air this issue I recommend that you run a series of short articles by professional moral theologians (possible sources on request). This is no job for amateurs like either one of us.

3. Please, one target at a time; no more sloppy shotgunning!

—E J KUREK, *director*
Research & Development
Jenn-Air Products Co Inc
Indianapolis

To the Editor:

The first thing I always do is read your editorials, as I almost always find them highly interesting. Your method of calling a spade a spade makes me feel good. I especially liked your last one, "Is Your Morality Showing?" Your summation in the last three paragraphs is excellent and should make a lot of engineers sit up and think.

—JOSEPH F REIS
Reis Associates, Tarrytown, NY

To the Editor:

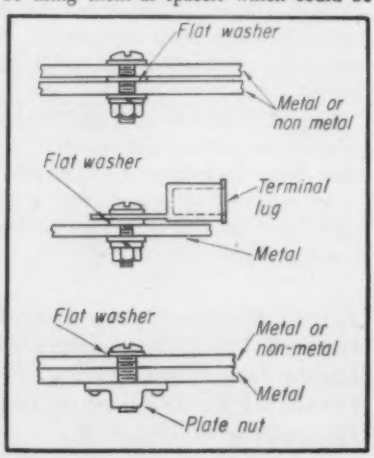
Thank you for your editorial in the current PE (Feb 20). The engineer—perhaps more than any other member of our society—must work to high standards. He is, therefore, the logical person from whom to expect leadership toward higher moral standards in every aspect of human activity. More power to you, in your efforts to keep your readers alert to the realities.

—CLARENCE G METCALF
Sharon, Mass

Washers as Spacers

To the Editor:

In your Feb 6 issue, p 61, you have six applications for flat washers by N. Dale Long. I think that you could have had some more applications. One would be using them as spacers which could be



done between metal and nonmetal materials. —Gonzalo Hidalgo
Orlando, Fla

• Our thanks to Mr. Hidalgo for suggesting the added applications—Ed.

Sinite Distributor

To the Editor:

We thoroughly enjoyed "Which Instrument-gear Materials Wear Least?" (Feb 27, p 37) and believe it to contain much data useful to gear designers. The wear resistance of Sinite gears seems amazing; can you tell us where to obtain this material? —Frank Samet
Kearfott Div, General Precision Inc
Little Falls, NJ

• The Eastern distributer is Haward Corp, 29 Porete Ave, North Arlington, NJ. Sinite is manufactured by Booker—Cooper Inc, 6940 Farmdale Ave, North Hollywood, Calif.—Ed.

COMING EVENTS

APRIL

4-7 . . . . Society of Automotive Engineers, National Aeronautic Meeting and Missiles and Aircraft Engineering Display, Commodore Hotel, New York

5-7 . . . . Institute of Environmental Sciences, Annual Meeting and Equipment Exposition, Sheraton Park Hotel, Washington, DC

9-13 . . . . American Society of Mechanical Engineers, 33rd Annual Oil & Gas Power Conference and Exhibit, Jung Hotel, New Orleans

11-13 . . . . American Society of Lubrication Engineers, Annual Meeting and Exhibit, Bellevue-Stratford Hotel, Philadelphia

19-21 . . . . Institute of Radio Engineers, 13th Annual Southwestern IRE Conference and Electronics Show, Dallas Memorial Auditorium, Dallas

20-21 . . . . Society of the Plastics Industry, 18th Annual Western Section Conference, Hotel del Coronado, Coronado, Calif

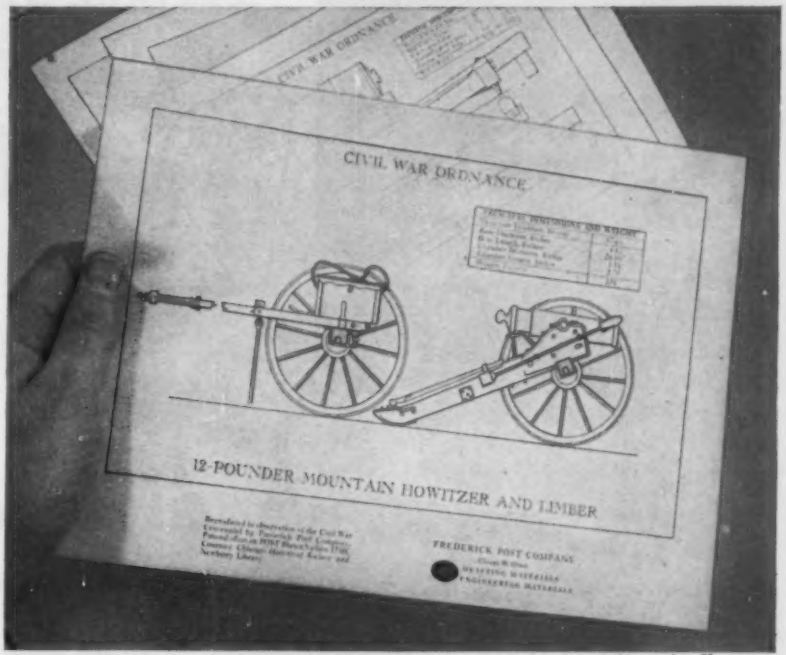
23-25 . . . . American Society of Mechanical Engineers, Metals Engineering Conference, Penn Sheraton Hotel, Pittsburgh

MAY

7-11 . . . . American Society of Mechanical Engineers, Engineering Institute of Canada, Hydraulic Conference, Queen Elizabeth Hotel, Montreal

For a listing of addresses of societies and associations send 25¢ to Product Engineering Reader Service Dept, 330 W 42nd St, NY 36. Ask for brochure R 32.

DRAFTING TRENDS



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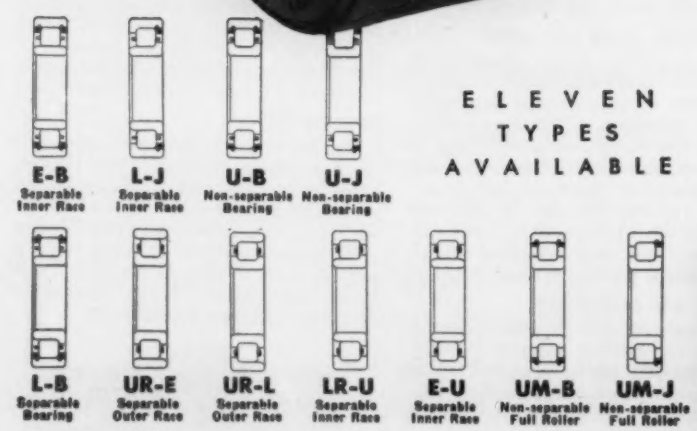

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5. AlSiBase has exceptional dielectric strength in thin sections. Measurements made to date on AlSiBase in the new thin sections indicate better dielectric strengths than those of similar ceramic formulations processed by conventional methods and tested on ¼" thick discs in accordance with A.S.T.M. D 667-44. A typical AlSiBase design in alumina had a dielectric strength up to 2000 ACV/mil at 10 mil thickness.

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Stewart Ashton, our Chief Engineer, reports on the all-new . . .

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HERE AT LAST is a simple, compact, space-saving package that provides *microsecond* response for controlling power to electric furnaces . . . and *for numerous other applications* and processes where temperatures must be precisely regulated.

A TRANSISTORIZED UNIT, the new Hayes pHayes-master now replaces costly and bulky saturable core reactors, tubes, magamps, powerstats, etc. — with *one*, small, smartly-designed control unit!

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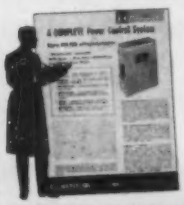

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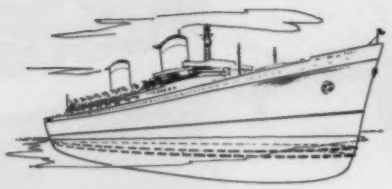
WHY DON'T THEY R&D..?



. . . a simple, inexpensive method for installing degaussing cables and equipment in merchant ships. The purpose of the degaussing system is to prevent the ship from distorting the earth's magnetic field and thus make it "invisible" to magnetic mines. Present degaussing coils are installed within the ship, close to the hull. They consist of many loops, some running fore and aft and some running athwartship. Generally, there are three sets: one runs the full length of the ship on both port and starboard sides; another set runs about one-fourth of the way back from the bow, crosses over to the other side and returns to the bow to form a loop in this area; the third set covers the rear quarter of the ship in the same way.

Though the present installation methods are satisfactory for conversions in cargo ships, large luxury ships such as the United States, Independence and Constitution, if converted to troop carriers in time of war, would require extensive removal and replacement of paneling, furniture and piping. And in refrigerated ships, the cables would have to pass through the "reefer" boxes. All of which would be an expensive and time-consuming operation at a time when speedy conversion would be of the utmost importance. The Norfolk Naval Shipyard, under contract from the Bureau of Ships, has studied the problem and, while the Bureau feels that the results of this study were satisfactory, they still think the problem deserves further investigation. Among the recommendations offered in the study: a method whereby some of the cable are located outside of the hull and a suggestion for installing cables through the ship's air ducts.

. . . a simple, effective, economical method of separating large quantities of oil from water discharged by ships at sea. Discharge of oily waste is considered a serious nuisance today; it is washed ashore where it contaminates beaches and endangers birds and marine life. At the present time, the US Government, through the US National Committee for the Prevention of Pollution of the Seas by Oil, is being urged by foreign countries to ratify an international treaty that makes it unlawful to discharge oily water from a vessel at any time while at sea. However, as a practical matter, it is pointless to ratify the treaty until an efficient separating unit is developed. The oil-water separators now carried aboard American-flag vessels are not effective when the specific gravity of the oil approaches that of water. And with recent advances in petroleum refining, specific gravities of oils that a ship transports or consumes can vary from 0.95 to somewhat greater than 1.0.

Specifically, the separator must be able to process water delivered by a pump having a maximum capacity of 600 gpm. It must separate Bunker "C" residual fuel with a specific gravity range of 0.95 to 1.00 (plus) at a rate of not less than 50 long-tons per hour. The mixture will have a concentration of oil ranging from 0 to 100% and the water will be either fresh or sea water. Temperature of the mixture will range from 28 F to 100 F with nominal temperature of about 60 F. The equipment must operate satisfactorily when the ship has a momentary roll of 30° (60° total angle) or a permanent list of 15°, or fore and aft inclination of 5°.

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.

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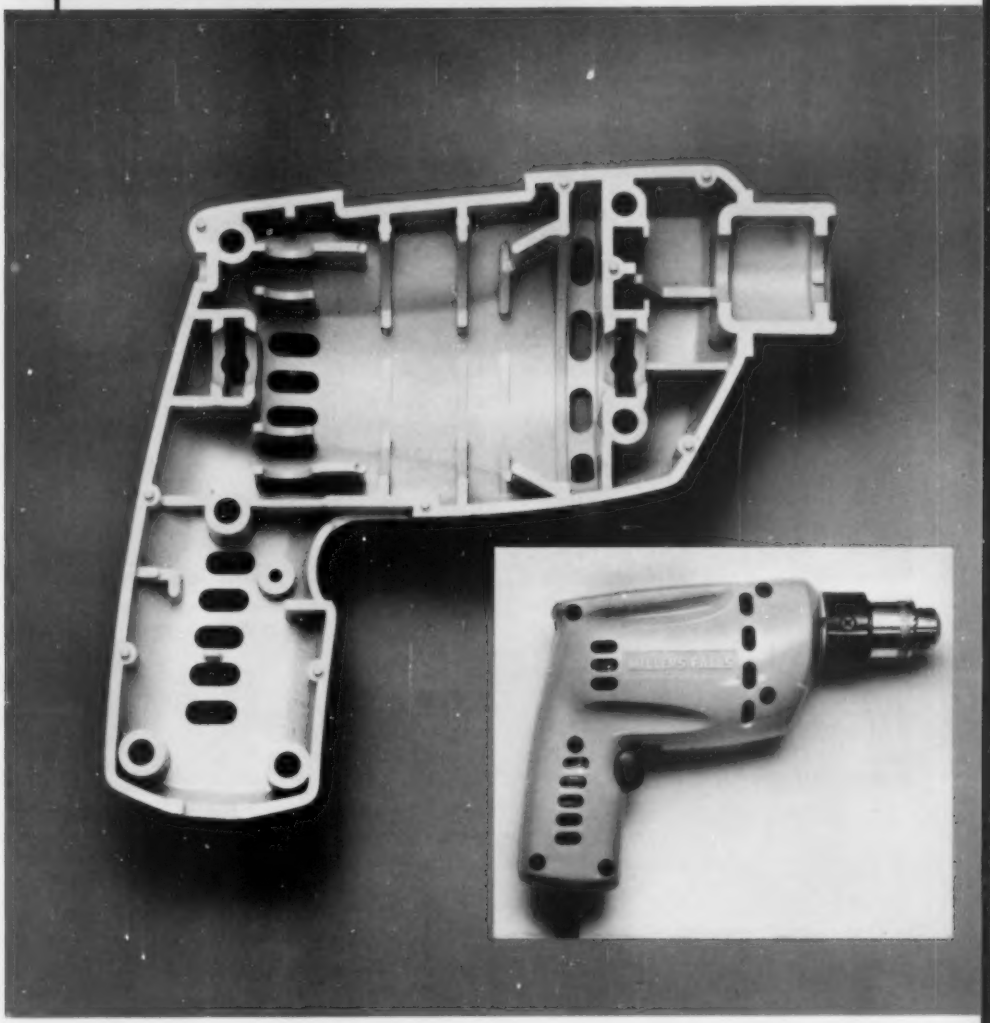
nylon resins

one of Du Pont's versatile engineering materials



New drill housing of ZYTEL® NYLON RESINS insulates ...eliminates costly machining operations

A basic design advance in power tools, this ¼" drill is made with a nonconductive housing of Du Pont ZYTEL nylon resin. Double-insulated, it protects the user against shock hazard. Other design advantages include a weight saving: the housing of ZYTEL is 20% lighter than a comparable housing of aluminum. It is self-extinguishing. It stays comfortable to the touch in hot and cold weather and after prolonged use. It is rugged, durable and impact-resistant.

In addition, the use of ZYTEL affords substantial production advantages. The two halves of the drill housing, though complex in design, are quickly and easily molded. The excellent dimensional stability of ZYTEL assures a perfect match of each half for screw inserts, assembly and flange matings. And the housing requires no machining operations whatever.

Molded by Nylon Products Corp., affiliated with F. J. Kirk Molding Co., Clinton, Massachusetts, for Millers Falls Company, Greenfield, Mass.

On the following page you will find additional examples of practical design improvements made possible by the combination of properties that ZYTEL nylon resins offer.

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nylon resins

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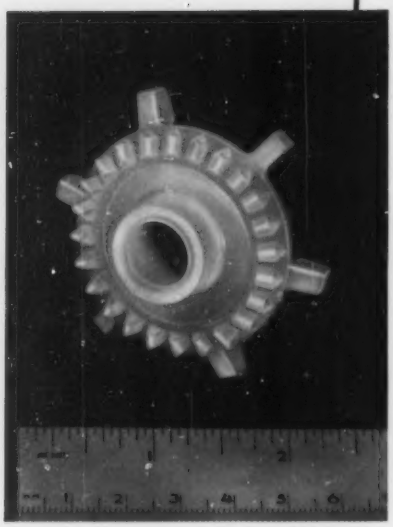
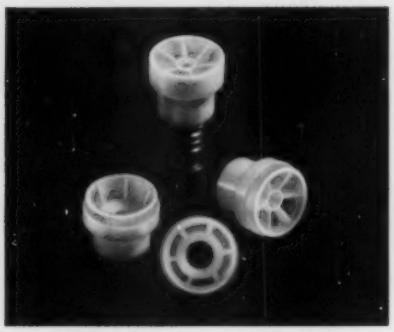
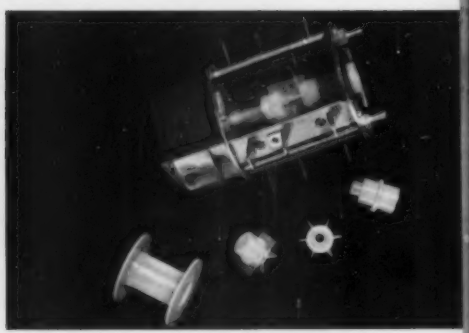


Parts of ZYTEL® NYLON RESINS perform reliably under attack by heat, impact and chemicals

This oil slinger swirls oil onto vital engine parts. It must be tough, resistant to impact, abrasion and attack by oil at high temperatures. ZYTEL provides all these resistant properties and permits economical injection molding of the part. (Molded by Sinko Mfg. & Tool, Chicago, Ill., and Danielson Mfg. Co., Danielson, Conn., for Briggs & Stratton, Milwaukee, Wis.)



These faucet-handle inserts are designed for interference-fit assembly and to act as an insulator against heat. These rugged parts of ZYTEL will withstand 116 inch-pounds torque at the stem between 20° and 160°F. They are expected to give at least 20 years of efficient service. (Molded for American Radiator & Standard Sanitary Corp., New York, New York.)



This compact switch relay uses parts molded of ZYTEL to withstand rugged treatment and yet operate quickly, smoothly and positively. Necessary in this application are good heat resistance, good electrical properties and high strength in thin sections. ZYTEL fills the bill. (Molded by Ritepoint Pen & Pencil Co., for Warco Industries, both of St. Louis, Missouri.)

An important factor in the design versatility of ZYTEL nylon resins is their ability to be molded to accurate tolerances without costly machining. Equally important is the wide variety of ZYTEL nylon resins available to meet special problems. All ZYTEL compositions have the basic properties of low friction, impact and abrasion resistance, high strength and resistance to chemicals.

Du Pont ZYTEL may help you, too, to improve the performance or the economics of a part or product. The coupon below will bring you information relating to your own problem or field of interest.

POLYCHEMICALS DEPARTMENT

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These are motors that are built to take on and tame the toughest jobs. Big, job-rated motors, available in frames larger than 445U, through 1000 horsepower. Perfect drives that can be used for station auxiliaries, in chemical plants, in rubber and paper mills and in the petroleum industry.

With motor coils completely sealed in a jacket of silicone rubber and housed in a compact, drip-proof enclosure, these Wagner® motors are suitable for use in highly humid atmospheres. They perform perfectly even after long exposure, and at elevated temperatures. Since moisture does not penetrate their tough silicone jackets, they are now used for many installations that once required totally-enclosed motors. Silicone rubber insulated motors cost less to buy than equivalent totally-enclosed fan cooled motors, since there is no need for expensive enclosures.

But your savings don't stop with initial cost. When rated to match normal load, Wagner silicone rubber insulated motors deliver rated horsepower at top efficiency. They have more overload capacity for temporary overloads . . . reduce downtime while they help keep production levels up.

Like to hear the whole money-saving story of these dependable Wagner silicone rubber insulated motors? Call your Wagner Sales Engineer . . . then settle back for some profitable listening.

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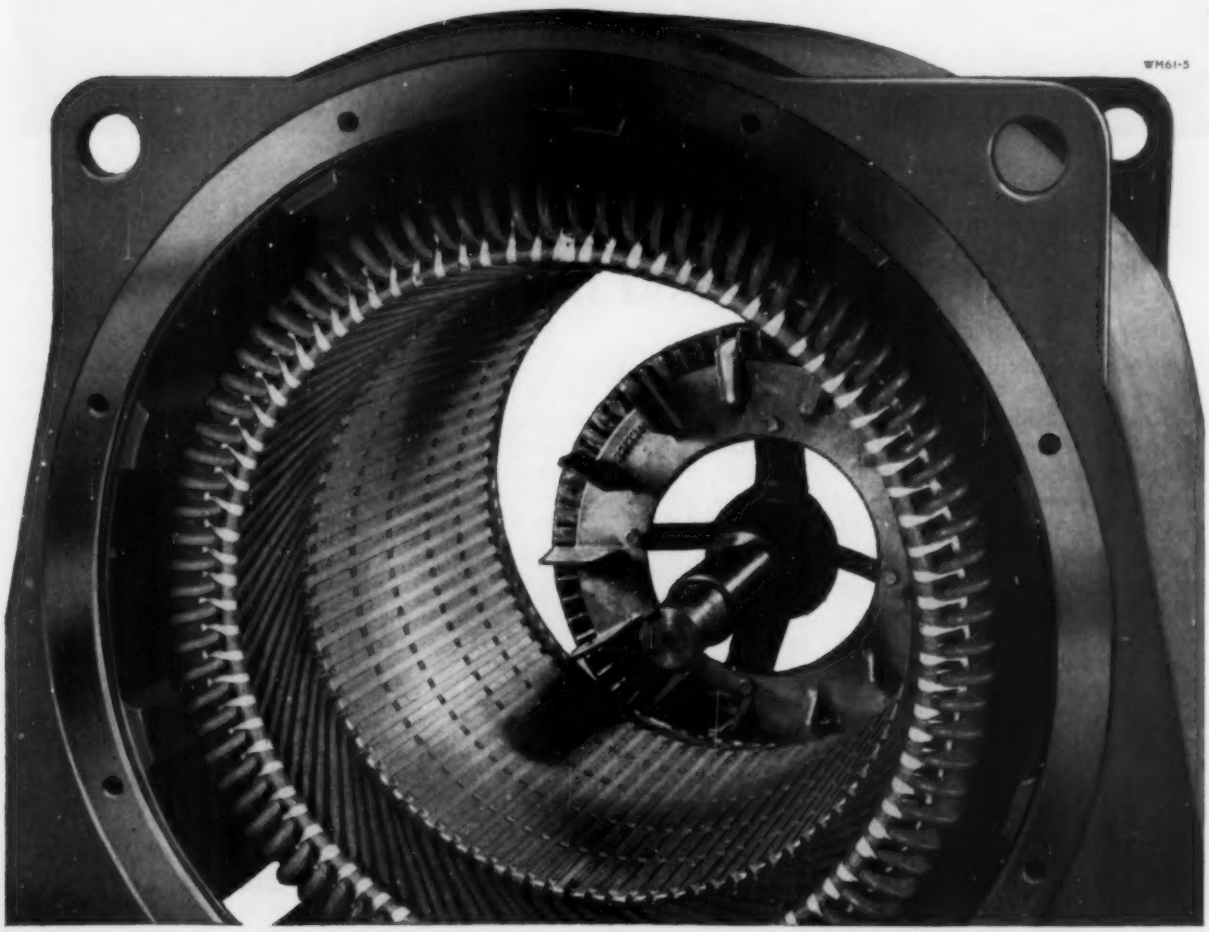

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To put these ideas to work we've taken to the road with a traveling value-analysis clinic, stopping in industrial centers all over the country. We've a truckload of displays representing our principal products to serve as starting points for discussions of the ideas. We're detaching specialists, technical men, mill men, executives to discuss and explain the ideas with all manufacturers who can attend the clinics.

We're also busy generating new ideas in an aggressive research and development program. And we plan to make available soon small, balanced value-analysis teams to go out in the field and work with individual company organizations—make specific suggestions and recommendations regarding materials, fabricating methods, design, etc.

Anaconda is on the move. If you have problems in which you think a new approach might help—call your Anaconda American Brass representative. Or write: Anaconda American Brass Company, Waterbury 20, Conn.

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PRODUCT ENGINEERING HORIZONS

APRIL 3, 1961

Who Says Engineers Can't Write?

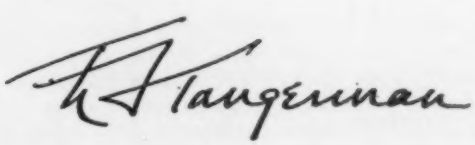
One canard gaining increasing currency is that engineers and scientists as a group cannot write and that humanists (meaning liberal-arts graduates) can. *This is pure hogwash.* The unadulterated facts are that neither group—as a group—is any better or any worse at writing than the other. There is considerable evidence, on the other hand, that the humanists have devised this criticism of engineers as "defense-by-attack."

Part of the broad problem is that many secondary school and college writing courses are not teaching writing at all, but teaching writing *appreciation.* We learn to appreciate the quality of the writing of Shakespeare, Hemingway and others. But we have very little practice in writing to convey our own ideas. Also, good writing is assumed to be an exclusive characteristic of the literati and not of the writer of a business letter or an engineering report. An inevitable result is that the man who attempts to write a literate or fluent engineering report is likely to be criticized as an amateur Shakespeare or a junior Faulkner.

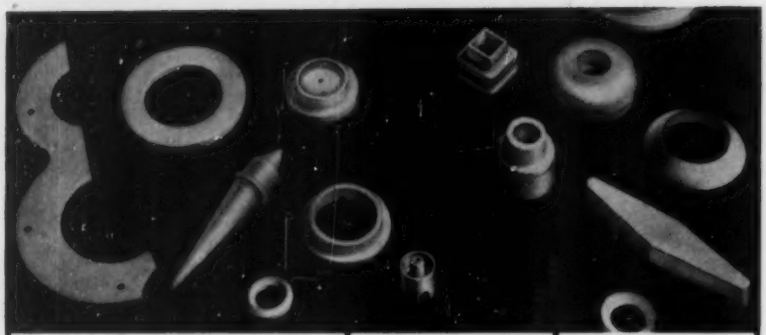
Our concern here, however, is with the unjustified attacks on the writing ability of engineers as a singled-out target group. Just for your own satisfaction, read some of the equivalent reports or letters of non-engineers—lawyers, historians, artists—*the writing is no better than your own.* Check further, and you will find that the typical liberal-arts graduate has had, if anything, less training at the university level in English and writing than has the typical engineer, and less training in the discipline of logical thinking so necessary to good exposition.

Basically, we all have overlooked the fact that communication occupies 70% of our waking hours and that, even more important in our present business atmosphere, communication is at least as vital to success as real knowledge or ability. Further, writing is a craft that takes training and practice, just as any craft does. When real skill, ideas and heart are added, it becomes an art.

There is another factor of major importance. Most engineers are so busy that they resent the time it takes to write, particularly the time it takes to write well, so that they readily accept the humanist contention that they cannot write. When engineering writing is bad, and it often is, our belief is that it is more a matter of "won't" than "can't."



PLASTICS
in Design Engineering



PROPERTY	TEFLON (TFE)	TEFLON (FEP)
Specific Gravity	2.1-2.2	2.1-2.2
Tensile Strength, 73°F	2500-3000 psi(a)	2700-3100 psi
Elongation, 73°F	100-200%	250-330%
Compressive Stress at 1% Offset	1000 psi	700 psi
Impact Strength, Izod Notched, 77°F	3.0 ft. lb./in. of notch	Does not break
Heat Distortion Temp., 66 p.s.i.	270°F	162°F
Coefficient of Linear Thermal Expansion (Approximate Values per °F)	5.5 x 10^{-5} in./in./°F	5.23 x 10^{-5} in./in./°F
Dielectric Strength, Short Time, 1/16"	400-500 v/mil(b)	400-500 v/mil(b)
Surface Arc-Resistance	700 seconds(c)	165 seconds(d)
Volume Resistivity	$>10^{15}$ ohm-cm.	2 x 10^{15} ohm-cm.
Dielectric Constant (60 Cycles)	2.0	2.2
Service Temperature Range (Max.)	+500°F	+400°F
Service Temperature Range (Min.)	−395°F	−395°F
Water Absorption	0.0%	0.0%
Flammability	Nonflammable	Nonflammable

(a) Tensile strength in oriented film may be as high as 15,000 psi.

(b) Value is 1000-2000 v/mil in thicknesses of 5 to 12 mils.

(c) Does not track.

(d) Samples melted in arc after 15 seconds, but did not carbon track.

This table compares the properties of Teflon* TFE and FEP. The newer FEP can be injection molded. In designing, consult your Garlock plastics specialist for best application results.

In designing intricate parts, consider the benefits of Teflon as a material.

Teflon offers a unique combination of properties unmatched by other plastics. It possesses the lowest coefficient of friction, the best non-stick characteristics, the most complete chemical resistance and the widest useable temperature range available in any plastic. Teflon eliminates lubrication, corrosion, contamination, seizing; it reduces friction, wear, space required, weight. Teflon can be used in a thousand different ways—for packings, gaskets and seals . . . for connectors, insulators, and test points . . . for valves, bearings, couplings, and insulation.

In producing intricate Teflon parts, consider the benefits of Garlock as a supplier. From virgin powder to finished piece, Garlock closely controls each step in the process to assure that the final part performs to your expectations. Complete facilities are at your disposal for molding, extruding, and machining of Teflon. If your application calls for special properties, Garlock will compound Teflon with selected fillers to greatly extend its service range. If you need unusually large configurations, Garlock will fusion-weld Teflon . . . the weld will have the same thermal, chemical and electrical properties as the Teflon itself.

Parts made from Nylon, Delrin*, C.T.F.E., Lexan† are also available from Garlock. Let your local Garlock representative quote on your design, or ask his assistance on any design problems concerning materials and applications. Call him at the nearest of the 26 Garlock sales offices throughout the U.S. and Canada. Or, write for Catalog AD-177. Garlock Inc., Palmyra, N.Y.

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*DuPont Trademark
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CAN MACHINES REALLY LEARN?

The usual answer: It all depends on what you mean by "learn." But simple learning machines are technologically possible, and experiments now in the laboratories may pave the way toward more sophisticated devices.

CHARLES J LYNCH, assistant editor

Machines that learn are a lively topic of discussion today. The nonscientific layman, fearing what he doesn't understand, views the prospect with alarm. In the development of an overeducated robot he foresees a threat to man's freedom. The engineer, by contrast, foresees a universal problem-solver serving as an adjunct to man's brain—in the same way that modern power sources multiply man's strength and endurance.

But the engineer is frankly skeptical. To him, a machine that will learn to perform something more than simple tasks is only a tenuous hope at the moment. Yes, experiments with more modest objectives have been encouraging . . . machines can learn. But only if you define "learn" in somewhat unintellectual terms.

Consider a tape-controlled machine tool. Its operator leads the machine through each step, doing precisely what he wants the machine to do, while the machine makes stenographic notes on punched tape. Thereafter, the machine takes over. It will repeat the process as many times as desired without further education. Did the machine learn? Most of us would agree that it did not. It merely copied the movements of the operator. And there's little difference between a machine that copies movements and a machine that copies convolutions of a cam.

Let's look at another example. Recently, A. L. Samuel of IBM programmed a computer to play checkers. Not only did it play a reasonably good game, but, with the help of several trick program routines, improved its game as it played until eventually it developed enough skill to beat all but the best contestants.

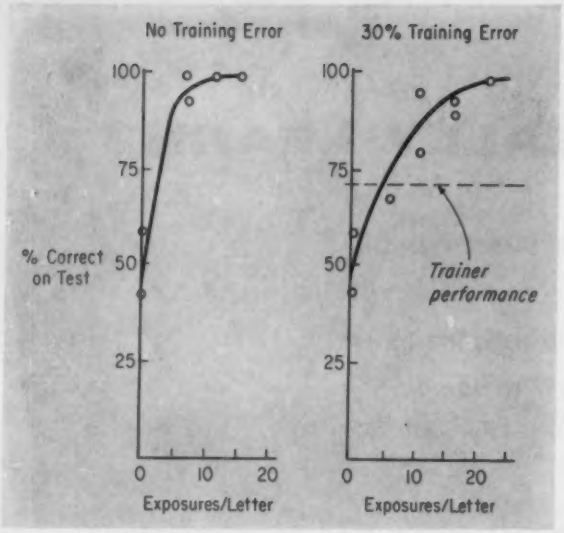
One of the ways the computer "learned" to improve its game was by storing records of past moves. It works this way: At any point in the game, the computer has several possible moves, to which the opponent can reply with several possible moves, to which the computer can then reply with several possible moves . . . and so on. Dr Samuel devised a mathematical way of evaluating the strength of the machine's position for each possible move. But its capacity was limited—it could look no more than, say, 3 moves ahead. It improved its play by storing the results of each look-ahead and using these data in future games. When a board position from a previous game recurred, the machine had the present 3-move look-ahead plus the previous 3-move evaluation—giving it, in effect, a 6-move perspective of the proposed move.

Certainly this machine did more than slavishly copy. But its learning was rigidly prescribed by the programmer—it was not only told *how* to learn, but *what* to learn. Even Dr Samuel was loathe to describe his creation in terms of special talents. "Computers so programmed," he said, "appear to learn from their experience, and in a restricted sense they even appear to think, but only an unthinking person would ascribe human intelligence to the machine."

Interestingingly enough, some of the computer's toughest opponents were actually novices. Because they were unfamiliar with classic strategy, they would lead the machine down unfamiliar paths and win the first game handily—but only the first game. The machine soon caught on to their unorthodox methods and drubbed them soundly. It was also rigged to type out such unnerving table-talk as "THE MACHINE WILL BEAT YOU IN 4 MOVES," and at the end of the game say politely, "THANK YOU FOR AN INTERESTING GAME."

The checkers-playing machine represents one of two approaches to the problem of building a machine that learns—that of a computer deliberately programmed to make judgments on the basis of past experience. These are sometimes called fixed-parameter networks. They are designed to do one job, to store information relative to that job and apply the sum of this experience to the particular task at hand. The other approach is a machine that builds its own logic patterns. Conceptually, in terms of learning patterns, it is perhaps a closer copy of the human brain. It does not learn "by itself" as the checkers machine did, but must be coached, "rewarded" and "scolded" when it performs, or fails to perform, a given task. It is called a random net or self-organizing system.

Several such machines have been simulated on ordinary general-purpose digital computers, and with somewhat encouraging results. Perhaps the most ambitious, and in some ways the most sophisticated project in this direction, is the *perceptron* conceived by Dr Frank Rosenblatt of Cornell Aeronautical Labs. It recognizes block



PERCEPTRON LEARNING CHARACTERISTIC shows, remarkably enough, that this machine can exceed the ability of its trainer. If he makes no mistakes when teaching the machine, it learns to discriminate between two letters with 100% accuracy after about 10 exposures. But even if the trainer purposely makes wrong identifications 30% of the time, it still climbs to 100% recognition, though this requires about 20 exposures. In a "noisy" test (letters with a random pattern of spots superimposed) the machine had more difficulty but still beat its artificially derated coach after about 25 exposures.

		Scanner Sees:		
		Blank	X	1
Control Dial Set at:	1	W6	E2	R1
	2	R2	E3	
	3	R3	E4	E5
	4	L4		R6
	5	L5		R1
	6	X6	↓6	R3

Instruction Table

TURING'S UNIVERSAL MACHINE, though only an imaginative exercise in logic, demonstrates what can be done with a simple mechanism. Its only action is to make marks in (or erase marks from) squares on a piece of paper tape. At any point in the problem, it has 6 alternatives: (R) move tape right one square, (L) move tape left one square, (W) write number 1, (X) write letter X, (E) erase, (!) stop. Which alternative it chooses depends on what the scanner sees

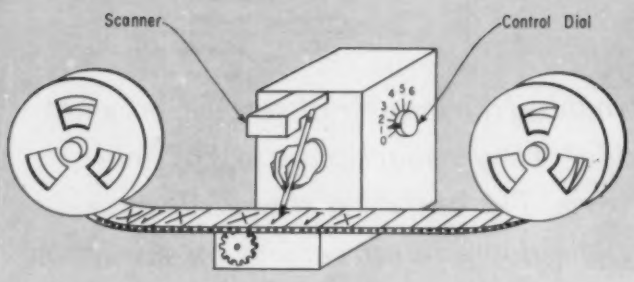
letters and other similar patterns, although this ability is not specifically built into the machine's hardware. Oversimplifying somewhat, it is a 20-by-20 array of photocells wired indirectly, and in a completely random fashion, to a series of summing devices. The value stored in each summing device is dependent on the signal from the photocell and a reinforcing signal provided by the machine's trainer. When the machine sees an X, and identifies it as an X, the trainer electrically reinforces this identification. Thus the machine learns to discriminate between patterns. The *perceptron* successfully learned to identify all the letters of the alphabet after 16 training exposures to each letter. And like other learning machines, it will exceed the ability of the trainer, though in this case, the trainer's ability must be artificially degraded.

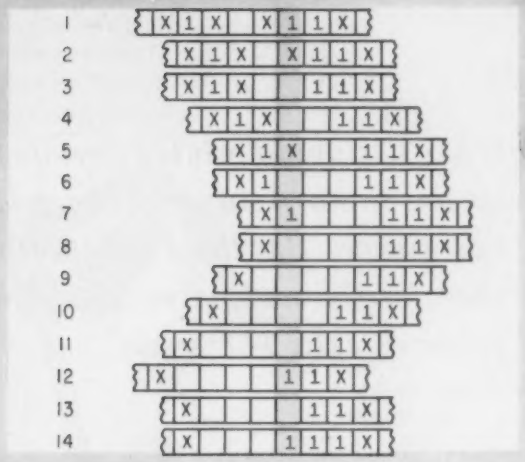
As a pattern-recognizer, this random net nevertheless falls far short of human ability. It is disturbed by noise in the pattern—or what the machine interprets as noise. Though it has learned to recognize an X, it will only recognize a certain kind of an X. If the X is a different size or a different typeface, or if the letter is slightly tipped or displaced, it treats these as new patterns. But this is not a unique limitation of the random-net type of device; fixed-parameter pattern-recognizers have the same difficulty.

Which type of machine shows most promise for the future? Learning-machine experimenters frankly admit that we haven't yet gathered enough information to make this decision. It would appear that the random net has most potential as a general-purpose learning device, since the material it learns is not designed into the hardware but "tutored in" after the machine is built. But the random net, being an unabashed copy of the human nervous system, also suffers from human inefficiencies. If it is taught to read the alphabet and used for no other purpose thereafter, it may as well be replaced by a fixed-parameter network of much less power and complexity. Furthermore, copying the human brain may not be the most effective way to make a learning device. Or, as Dr Samuel puts it, "Just as man has found it more expedient to exploit the wheel than to copy the locomotion techniques of men and animals, so he may be able to develop useful learning machines using quite different techniques than those of the brain."

There are other difficulties as well. Making an artificial brain presupposes that we know how the human brain functions and how it is assembled. Unfortunately, we do not. We know that the brain's neurons perform a function similar to the logic elements of a computer but we don't know their exact function or interrelationships. And even assuming we knew how to assemble them, present-day artificial nerve cells are far too bulky. It is estimated that the much-folded cerebral cortex contains something on the order of 10^{10} neurons in a volume of slightly less than one liter. The best we can do today is about 10^{3} active elements per liter. Even though the artificial elements are faster by a factor of about 10^{3}, and assuming we could use this speed to compensate for size, we are still at least three orders of magnitude away from simulating the brain on anything like reasonable terms.

But all this complexity may not be necessary. An





on the paper and the position of the control dial, which the machine moves in response to various input conditions (see typical table of instructions at left). With an infinitely long tape and an infinite number of positions on the control dial this simple machine, its creator claims, could do anything that any other logical mechanism could do.

Suppose the problem is to add 1 and 2. The machine writes the two numbers, (for 2, it writes two 1's) and encloses them with X's. It begins at the position shown above. With the scanner seeing a 1, and the control dial at position 1, the instruction table at left tells it, "Move one unit to right and keep control dial set at 1." It now sees an X and the instruction table says, "Erase and move control dial to 2." The first 14 steps are at right. After erasing the X's between numbers, it adds by shuttling back and forth between 1's, erasing the 1 at left and adding it to the number at right—until it meets the X at left. Here it erases the X, moves back to put an X at the end of the three 1's, and then stops. A laborious process—but it will add any two numbers with just these few operations and the brief table of instructions.

analysis by the late A. M. Turing shows that a very simple mechanism can perform remarkably complex tasks. Turing's now-famous universal machine is essentially a symbol-manipulator. As conceived by the mathematician, it literally writes with a pencil on a long strip of paper in response to instructions from a logical control unit. Though it has only six alternative modes (see sketch above), if it were given sufficient tape and control instructions it would be capable of solving any problem in logic.

Could any simple device be capable of such complex action. There is evidence to indicate that it could; even simpler machines have surprised their creators by doing things wholly unexpected from an analysis of their logical powers. For example, a group of investigators in England built a small battery-powered electromechanical turtle which was designed to seek out dim light sources but shy away from bright ones. Its home was a hutch containing a 20-watt bulb and suitable connections for recharging its batteries. It also had small feelers so that, when it encountered an obstacle in its explorations, it would back away and try again until the obstacle was either pushed out of the way or circumvented.

Though the small creature's brain contained only two logical elements, its behavior was remarkably unpredictable. Without a light source to guide it, the animal explored continuously, its photocell "eye" looking in all directions. In this way it covered a large area of floor in a short time. When it sighted distant light, it approached until the light got too bright for its threshold circuits, at which point it sheared abruptly away. Rather than blunder blindly into the light, it circled around it in a complex path of approach and withdrawal. If there were two lights, it would stroll continuously between them. When its batteries began to run down, the light in its hutch no longer seemed too bright and it returned to connect itself to its battery charger and prepare for another round of exploration.

Not all such experiments are that successful. In a short technical note in the scholarly *Proceedings of the IRE*, Feb. '59, headed, "A Small Brain, Normal for Its Size," H. E. Kallman reported his attempt to duplicate the turtle experiment. But his was an "improved" turtle; it would seek out a light but did not need recharging. Admitting that his purpose for building the electronic pet was "not to coddle it, but because I wanted to see how a simple, wholly known brain behaves," he reported:

"When completed as planned, the beast was turned loose and raced around. It did what it could—and was an utter bore. I put it aside to consider where I might have slipped up . . . After a year's reflection the matter turned out to be quite simple: The beast had nothing to do. Having improved it to need no recharging, I had removed the suspense of whether it would find its charger in time to survive, and vicarious satisfaction whenever it did. This insight brought out a dilemma: whether to leave it with no aim in life, or to retrogress by giving it a need not needed. Another year's cogitation and a way out, copied from life: If ever I go back to the pet, first thing I shall give it is a suitably simple TV set to watch.

"And while I write, I begin to wonder: It may still be a bore." ■

When designing printed circuits for trouble-free industrial service, why not let the military standards be your guide? They're backed by lots of field experience. But their specifications vary. The author, a standards expert, therefore has compared them, boiled them down to agreement on minimum requirements. The result:

UNIVERSAL STANDARD for PRINTED WIRING BOARDS

FRANK W WOOD JR
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DEFINITIONS

Printed Wiring—printed circuit, or portion thereof, intended primarily to provide point-to-point electrical connections or shielding.

Base—the insulating support for the printed pattern.

Conductor Pattern—design pattern of any conductive material having low electrical resistance.

Land or Terminal Area, Boss and Pad—Portion of a printed circuit used for making electrical connections to the conductive pattern, such as the enlarged portion of conductor material surrounding a component mounting hole.

Feedthrough or Interface Connection—a conductor that connects conductive patterns on opposite sides of a printed circuit base.

Jumper — point-to-point electrical connection made by hookup wire where the connection cannot be made in the printed circuit.

Printed Contact—portion of a printed circuit that connects the circuit to a plug-in receptacle and performs the function of a pin in a male plug.

Pinholes—small holes occurring as imperfections in the conductive pattern.

Indexing Holes—holes placed in a printed-circuit base for accurate positioning of the base in assembly or manufacturing operations.

Current-carrying Capacity—the maximum current that can be carried continuously by the conductor pattern without causing degradation of electrical or mechanical properties of the printed circuit board, or of attached components.

Printed wiring can lead to a better and lower cost product, but it can be accomplished in many different ways with widely different design methods and varying levels of performance. To standardize on the design areas that affect quality and reliability of printed wiring, the military services have set up minimum specifications for printed wiring boards needed in military electronic equipment. Specifications issued to date are:

Printed Wiring General Specification, MIL-P-21193. Naval Bureau of Ordnance.

Printed Wiring for Electronic Equipment, MIL-STD-275. Navy Bureau of Ships.

Printed Circuit Boards, XAR-153. Navy Bureau of Aeronautics.

Design Requirements for Auto-Sembled Army Signal Electronic Equipment, SCL-6225. Signal Corps.

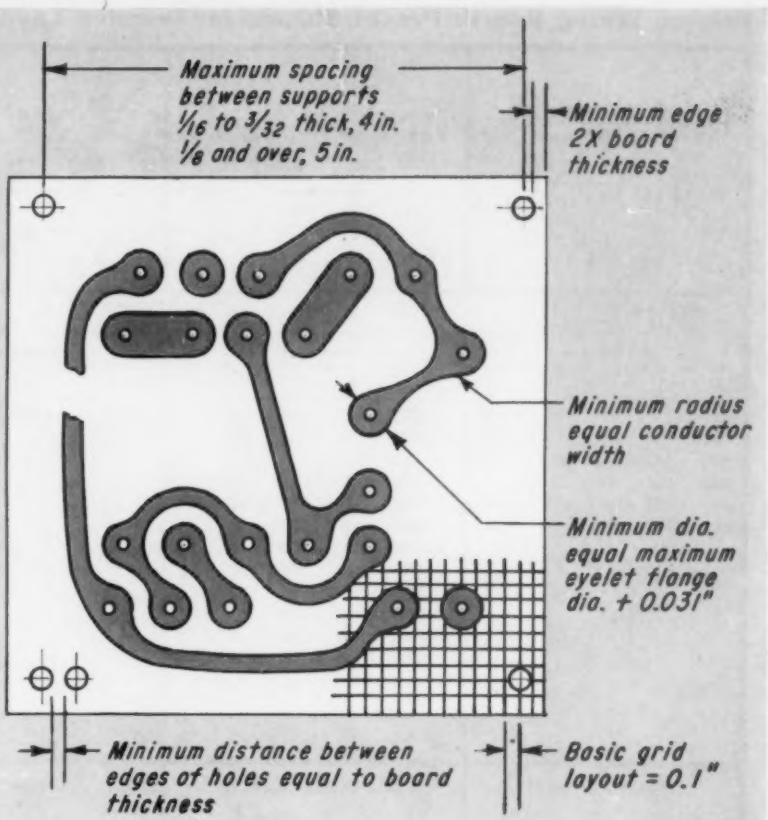
Printed Circuit Terms and Definitions, MIL-STD-429. Signal Corps, Bureau of Ships, and Air Force.

Minimum requirements for the issuing agencies vary in some design areas. For example, the minimum spacing between conductors is 0.040 in. for the BuOrd specification, 0.031 in. for the BuShips specification, and 0.026 in. for the Bureau of Aeronautics. To avoid confusion in designing to these different standards, the design specifications on the next seven pages are based on the minimum specification that carries the maximum safety factor. This one standard therefore will meet specifications on all contracts regardless of the contracting agency or commercial products.

Specifications for Board Layout

Minimum spacing of adjacent conductors	
Max operating peak voltage difference	Minimum spacing, in.
0 — 150	0.031
151 — 300	0.062
301 — 500	0.125
over 500	0.0003 in. per volt

Minimum Conductor Width		
Max current, amp, at 20° C		Minimum line width, in.
0.0014 copper	0.0028 copper	
5.8	6.5	0.250
4.5	5.0	0.125
2.5	3.5	0.062
1.7	2.5	0.031

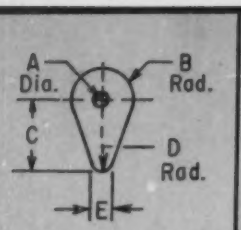

Maximum spacing between supports 1/16 to 3/32 thick, 4 in. 1/8 and over, 5 in.
Minimum edge 2X board thickness
Minimum radius equal conductor width
Minimum dia. equal maximum eyelet flange dia. + 0.031"
Minimum distance between edges of holes equal to board thickness
Basic grid layout = 0.1"

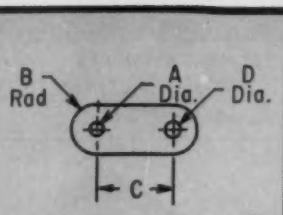
These specifications meet requirements of MIL-STD-275 and MIL-P-21193, and call for a basic grid dimension of 0.10 in.

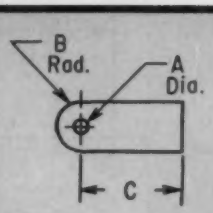
PRINTED WIRING MATERIALS THAT MEET MILITARY SPECIFICATIONS

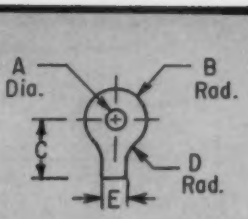
Material or Function	Description of Material	Commercial Designation	Military or Federal Specification	Referenced Printed Wiring Specification
Base material (undad)	Epoxy resin Glass fabric filler	GEC	MIL-P-18177	
Base material (undad)	Phenolic resin Paper filler	XXXP	MIL-P-3115B MIL-P-13949	MIL-P-21193 BuOrd SCL-6225 Sig. Corps
Conductor	Copper 99.5% pure	ASTM-53-48		MIL-P-21193 BuOrd
Solder	60% tin–40% lead 63% tin–37% lead		QQ-S-571	
Flux	Noncorrosive Moderately active		MIL-F-14256	SCL-6225 Sig. Corps
Moisture protection	Varnish		MIL-V-173	
Corrosion protection and soldering aid	Gold flash immersion 0.000,05 in. min			MIL-P-21193 BuOrd
Noncorrosive surface for wiping contacts	Nickel-rhodium plating 0.000,25 to 0.0005 nickel 0.000,02 to 0.000,05 rhodium			MIL-P-21193 BuOrd
Noncorrosive surface for non-wiping service	Nickel-gold plating 0.000,25 nickel min 0.000,02 gold min			MIL-P-21193 BuOrd
Clad base material	Plastic material, foil clad		MIL-P-13949	MIL-P-21193 BuOrd

Printed Wiring Board: Precut Shapes for Drawing Layout









FILLETS

Dimensions				
A	B	C	D	E
.031	.078	.171	—	.050
.062	.125	.250	—	.050
.040	.140	.340	.040	—
.040	.156	.346	.040	—
.062	.125	.375	—	.062
.062	.265	.750	—	.125

Dimensions			
A	B	C	D
.093	.125	.406	0
.093	.125	.500	.093
.062	.125	.700	.062
.156	.250	.500	.156
.062	.125	.250	.062
.062	.087	.076	0
.095	.125	.093	0
.095	.200	.100	0
.100	.250	.156	0
.062	.200	.200	0
.062	.300	.200	0
.062	.250	.275	0

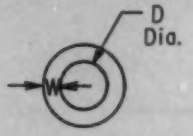
Dimensions		
A	B	C
.062	.187	1.50

Dimensions				
A	B	C	D	E
.046	.093	.187	.250	.062
.062	.218	.313	.500	.125
.062	.218	.313	1.03	.250
.093	.187	.344	.468	.125
.093	.187	.344	.843	.250
.062	.150	.350	.437	.125
.046	.187	.375	.500	.125
.125	.200	.375	.562	.125
.080	.281	.437	.281	.125
.093	.250	.500	.250	.125
.156	.250	.500	.687	.250
.062	.250	.562	.812	.125
.062	.250	.562	.843	.250
.093	.312	.563	.250	.125
.062	.312	.594	.750	.250
.046	.375	.750	1.00	.250

TERMINAL CIRCLE

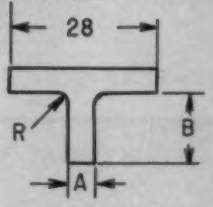
A	B	A	B
.125	.031	.500	.125
.187	.062	.562	.062
.188	.040	.562	.187
.200	.080	.600	.080
.250	.040	.625	.062
.250	.062	.625	.125
.312	.062	.687	.187
.375	.062	.750	.062
.400	.080	.750	.125
.437	.062	.875	.062
.437	.125	.875	.125
.500	.062	1.00	.062

UNIVERSAL CIRCLE



D	W
.250	.062
.312	.093
.375	.125
.500	.187
.500	.250

TEE



A	B
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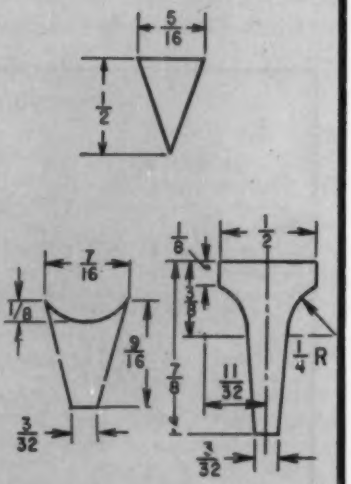
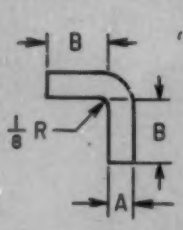
.125	.250
.062	.187

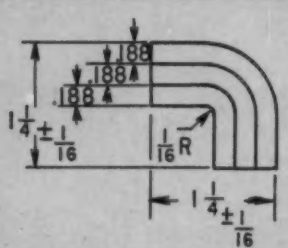
FILLET ADAPTERS

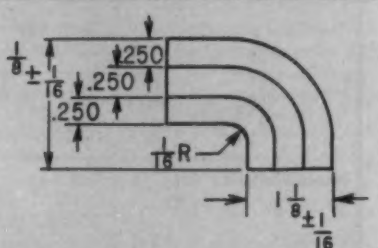


ELBOWS



A	B
.250	.500
.125	.375
.062	.375

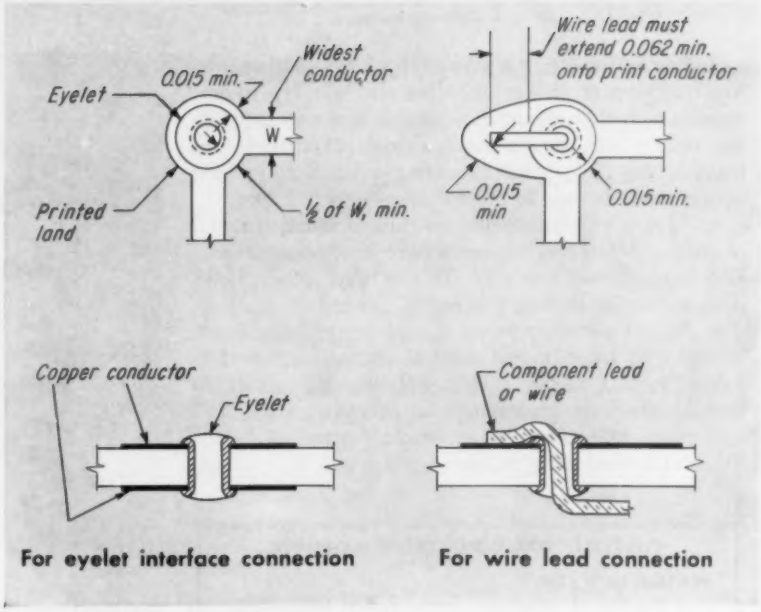




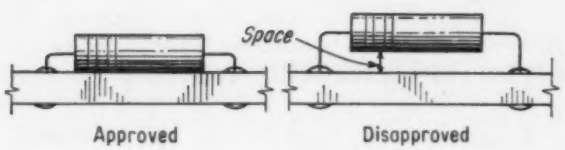
DESIGN GUIDE FOR PRINTED BOARD LAYOUT

1. Use modular layout.
2. Use modular-size board.
3. Keep input at maximum distance from output.
4. Run ground bus around edges of board.
5. Leave room between conductors for mounting hardware (nuts, washers, etc.).
6. On vertical boards, place tubes at top of board.
7. Orient tubes and components for best airflow.
8. Support boards at close intervals (see standard).
9. Provide room for identifying parts.
10. Number each connector pin or termination.
11. Mount all components parallel to board for max resistance to shock and vibration.

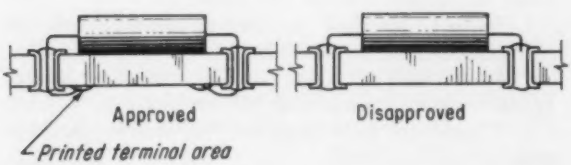
Land Design



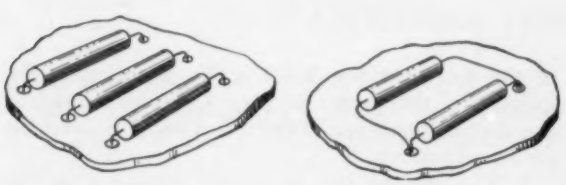
GUIDE TO ASSEMBLING COMPONENTS



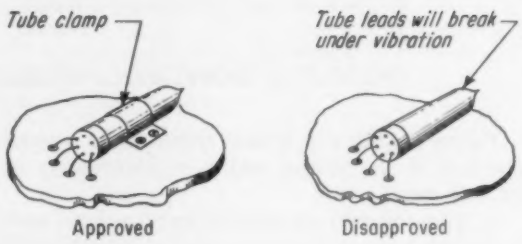
1. Axial lead components such as resistors and capacitors must be mounted flush against the board surface.



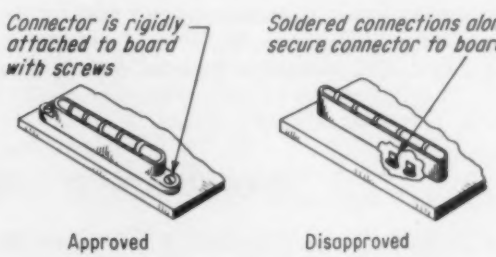
2. Component leads must pass through holes in the board, and must be soldered to printed terminal areas on the opposite side of the board.



3. Each component lead must have a separate mounting hole.



4. For subminiature tubes without sockets (flexible leads soldered directly to the printed wiring conductors) the tube must be rigidly supported.


Connector is rigidly attached to board with screws
Approved
Soldered connections alone secure connector to board
Disapproved

5. The body of tube sockets, connectors and similar parts subject to insertion and withdrawal forces must be rigidly supported without depending on the soldered electrical connections for mechanical support.

continued, next page

6. Individual mounting is required for heavy components. Any transformers, chokes and other relatively heavy components should be mounted separately and connected to the circuit with conventional wiring. If critical lead length makes this separate mounting unsatisfactory, these design methods may be helpful:

A. Mount all components on printed board material of adequate thickness to support the heavy components, and counterbore for tube sockets and other items designed for the thinner boards.

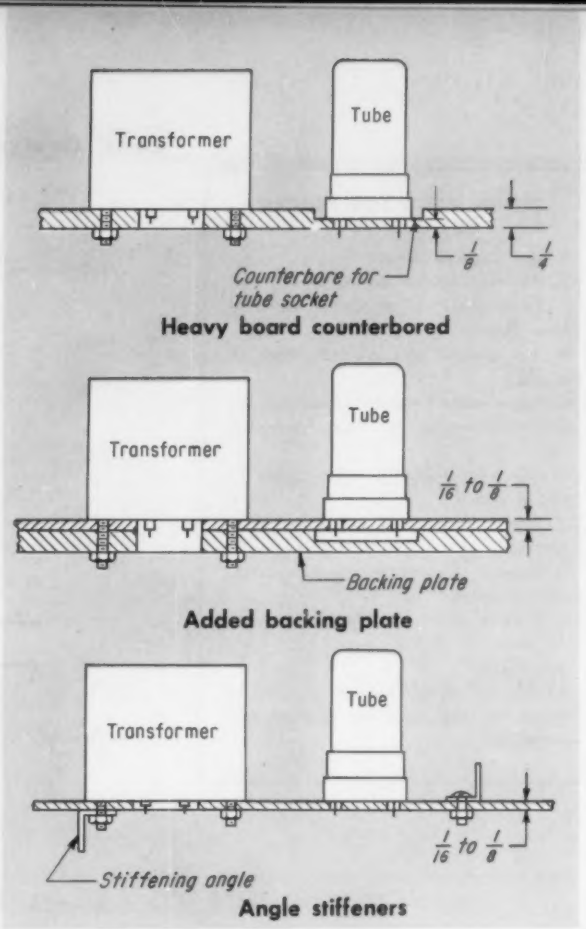
B. Mount all components on regular-thickness board backed with an additional sheet of phenolic attached to printed wiring board. This will require cutouts in backing plate for protruding components.

C. Use stiffener angles or brackets attached to the board at critical-strength areas.

CHECKLIST FOR COMPONENT ASSEMBLY

WATCH OUT FOR:

- Shorting of component leads against tube clamps or metal cases of such components as capacitors and potentiometers.
- Hardware shorting adjacent printed leads.
- Excess length for component leads.
- Components mounted flush against board surface.



QUALITY CONTROL REQUIREMENTS FOR PRINTED WIRING

Failure to meet any of these requirements is cause for rejection of the printed wiring board assembly under military specs:

1. All metal surfaces intended to be soldered must be completely covered by solder, including component leads and eyelets.

2. Unsoldered areas on the copper conductors must not be closer than 0.1-in. radius from another unsoldered area. The total amount of unsoldered area must not exceed 5% of the total board area.

3. Solder spots must not reduce the minimum allowable spacing between conductors. (See table at top of page 43 for minimum spacing of conductors.)

4. Avoid cold, oxidized or fractured solder joints.

5. Excessive solder lumps or peaks must be removed. Outline of eyelet or lead must be distinguishable under solder coating. Globule of solder may hide a cold solder joint.

6. Chemical decomposition or fungus growths on the board or components are not permitted.

7. Burned, scorched or heat-damaged boards or components must be avoided.

8. Solder shall not appear on the component side of boards designed for soldering only on one side.

9. Component color codes and identification markings must not be damaged.

10. No flux residue permitted on board or components after soldering and cleaning.

MARKING AND COMPONENT IDENTIFICATION

Printed wiring offers possibilities for component identification more permanent and with more useful information than is found on conventionally wired equipment. Some marking requirements are necessary to meet military specifications; other recommendations offered here are an asset in the production, testing and maintenance of printed wiring board assemblies.

Marking may be accomplished either by ink marking of the printed wiring board or by incorporating the marking in the copper layer on the board. Making the identification a part of the etched design is preferable for several reasons:

1. The marking can be located accurately on the scaled-up master drawing.

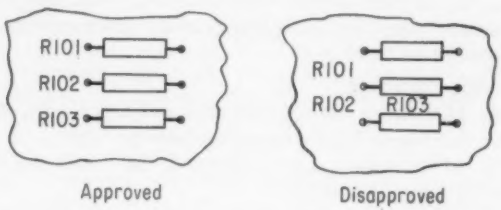
2. Permanency will not be affected by any subsequent cleaning processes the board will go through.

3. Location, size of characters and type face are determined on the master drawing, and no other instructions are required.

Required information

All printed wiring boards for military applications must contain the following identification information:

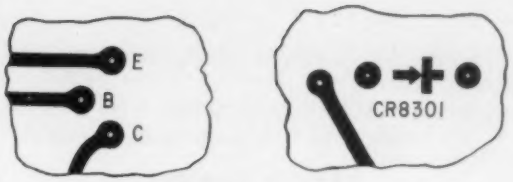
1. Each electrical component must be identified by a reference designation selected from MIL-STD 16.
2. The assembly must be identified by the manufacturer's identification symbol, the assembly drawing number, and the revision letter shown on the face of the board.
3. Minimum size of all letters and numerals is $\frac{1}{8}$ in. high with minimum line width of 0.010 in.



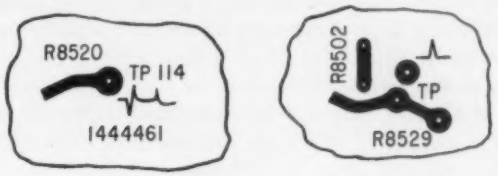
4. Component identification must be positioned to identify a specific component on the board without any chance of associating the part with another component.

When the marking is incorporated as part of the master drawing, additional information can be easily added that will help in the assembly, testing and repairing of the board. For example:

Component orientation can be indicated by a keying symbol such as a dot for tube sockets or a schematic symbol to show the direction of a crystal diode. Transistor lead hookup can be indicated by letters E, B, C, S



near the destination points of the emitter, base, collector, and shield leads.



Test points can be indicated by the letters TP and a designation number. Additional helpful information can be provided by including the correct voltage that should exist at a particular point in the circuit.

Waveforms can be shown on the printed wiring board to aid circuit testing.

IDENTIFICATION CHECKLIST

1. Is marking located so it can be seen without moving any components?
2. Does the clearance between the marking and etched conductors meet the minimum spacing requirements to prevent a shorting path between conductors?
3. Is marking-line width adequate to prevent undercutting in the etch bath?
4. Is marking legible?

PROTECTIVE COATINGS

Printed circuit board assemblies must have a protective coating to prevent moisture and fungus damage to the board and assembled components. A variety of processes are available but the following procedure covers materials, application and quality-control specifications that will meet military requirements.

CLEANING

Materials Required

Xylene–Federal Specification TT-X-916
Acetone–Federal Specification O-A-51
Acid swabbing brush
Cleaning tank

Safety Precautions

Work area must be well ventilated; operators must avoid inhalation of fumes and excessive skin contact. Face and eyes must be protected.

Preparation

Add one part xylene by volume to one part acetone by volume in a quantity suitable for complete immersion of the printed circuit board assembly in the cleaning tank.

Procedure

Cleaning shall be by one of these two processes, with combined wash and rinse immersion time not exceeding 10 minutes:

Assemblies with no electromechanical parts:

1. Immerse for 5 minutes in agitated solvent.
2. Scrub solder joints and board surfaces with solvent-saturated brush.
3. Immerse for 1 minute in agitated solvent.
4. Dry immediately with low-pressure filtered air.

Unsealed electromechanical parts or coil assemblies on one side of the board:

1. Immerse the board for 5 minutes in solvent (not agitated) to a depth that will allow solvent to flow over all areas except unsealed electromechanical parts or coil assemblies.

continued, next page

2. Scrub solder joints and board surfaces with solvent-saturated brush.

3. Immerse for 1 minute in solvent.

4. Dry immediately with low-pressure filtered air.

VARNISH COATING

Materials Required

Varnish–MIL-V-173A (moisture- and fungus-resistant)

Thinner–TT-X-916 (xylene) Use for touchup cleaning

Masking Tape–Minnesota Mining and Manufacturing Company, No. 202

Safety Precautions

Work area must be well ventilated; operators must avoid inhalation of fumes and excessive skin contact. Face and eyes must be protected.

Preparation

Cleaning. The board assemblies must be thoroughly dry and clean, free from oil, dust and solder flux.

Masking. The coating material must not be applied to any surface or part where the treatment will interfere with the operation or performance of the assembly. Such parts will be protected by masking with masking tape, including:

1. Adjusting-screws on trimmer potentiometers.

2. Electron tubes and sockets. Remove tube and tube shield, and mask the socket with tape or insert a dummy tube. (Defective tubes may be used for dummies.)

3. Contacts and test points. Protection must cover the entire contact area.

4. Resistors over 2-watt rating. Coating material must be masked to prevent smoking or carbonization of coating in use.

Application Procedure

The varnish must be applied full strength by dipping, brushing, or spraying. The resulting dried film shall meet the following requirements:

1. Smooth, clear, transparent finish–free from bubbles, filaments, cracks, or breaks.

2. Metal parts coated as a convenience with the entire assembly must be completely coated even when not requiring protection.

Drying Procedure

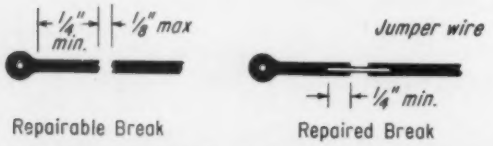
1. The coated boards must be allowed to air-dry, tack-free, for 1 hour before removing masking tape.

2. After masking tape is removed, the boards must be air-dried for 4 hours more.

3. All coated boards must be submitted for a final inspection.

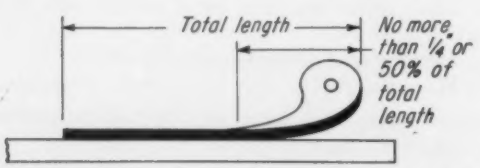
REPAIRING PRINTED WIRING BOARDS

Certain processing defects on printed wiring boards can be repaired at less cost than replacing with a new board. Following are the types of defects that can be repaired, and the methods used to ensure that the repaired area is comparable to an area requiring no repair:



A. Breaks in printed conductor paths where the width of the break is no greater than ⅛ in. and the break is not within ¼ in. of a soldered connection.

Repair by soldering a jumper wire in position to bridge the gap. Breaks must not be repaired by solder-bridging alone. The jumper must extend a minimum of ¼ in. on both sides of the break.

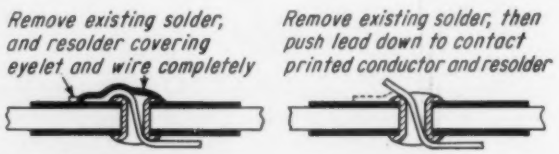


B. Printed conductor paths that have lifted for a distance of not more than ¼ in. and for not more than 50% of total length.

The "lifted" conductor is repaired by cementing it down after installation of components.

C. Excess solder.

Excess is removed by reheating the solder joint with a pencil soldering iron, removing all solder with a brush, and then resoldering the joint. Outline of eyelet or lead must be distinguishable under the solder coating.


Remove existing solder, and resolder covering eyelet and wire completely
Remove existing solder, then push lead down to contact printed conductor and resolder

D. Insufficient solder.

Such areas are repaired by reheating the soldered joint with a pencil soldering iron, removing all solder, and then resoldering the joint. Soldered component leads must contact the printed conductor and be completely covered with solder.

E. Damaged or incorrectly located components.

Components must be removed by cutting the component leads on the component side of the board close to the surface of the board or eyelet.

Component lead left in board is removed by applying a pencil soldering iron to the lead and removing it when the solder becomes liquid.

Cleanup After Repairs

All repaired printed wiring boards must be examined for the following defects that might be a result of the repair.

- **Flux residue.** Flux must be removed with solvent.
- **Break in protective coating.** Breaks can be repaired by a single brush-coat on each repaired joint.
- **Designation marking** must not be smeared or covered by new component.

Engineering specifications for acceptable repairs must require reinspection after repairs, with no relaxation in the requirements previously given under quality control, marketing and component identification, and protective coatings. If this guide is followed, the repaired board will be as reliable as a new one.

For REPRINT of above article, just check 598 on one of the Reader Service cards found in this issue.

EDITOR'S NOTE: These earlier articles have discussed design problems encountered in applying printed wiring techniques to control circuits for industrial equipment.

Choosing the Right Soft Solder Alloy, Mar 6 '61, p 39—Comparison of 28 basic types including alloys for electrical connections and printed wiring. (A forthcoming article by the same author will cover the design of soldered electrical connections.)

How to Choose the Right Solder Flux, June 13 '60, p 43—Up-to-date flux-selection guide based on chemical origin covers all significant types used for electrical joints.

The Newest in Molded Printed Circuits, Nov 21 '60, p 88—Updates a thick-foil process, first introduced three years ago; discusses new flexible insulator and wraparound shape adaptable to multiple-layer circuits.

Hard Harness for Easier Wiring, July 11 '60, p 64—Cabling method uses a covering of fiberglass and resin molded into a rigid bundle.

Photosensitive Glass Plus Chemical Machining, July 11 '60, p 66—Includes use of this material and process for printed circuit boards for service at temperatures to 900 F.

For Best Results with Printed Wiring, Apr 4 '60, p 57—Authors say be satisfied first that etched laminate is better than conventional wiring for the application. Then, they offer recommendations for specific design problems faced in selecting conductor dimensions, simplifying circuit layout, preparing master drawings and piercing holes.

Stationary-wave Soldering of Printed Circuits, Mid-Oct '57, p G-17—Digest of British paper discussing angled-entry method that prevents trapping of flux.

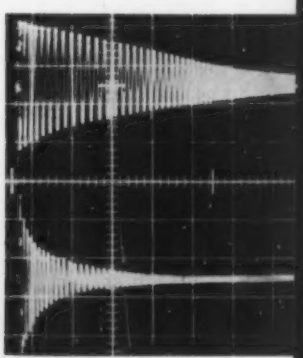
Molding Moves In on Printed Circuits, Sep 30 '57, p 90—First article on the heavier-conductor method with multilevel circuits. (Also see later article, Nov 21 '60, p 88.)

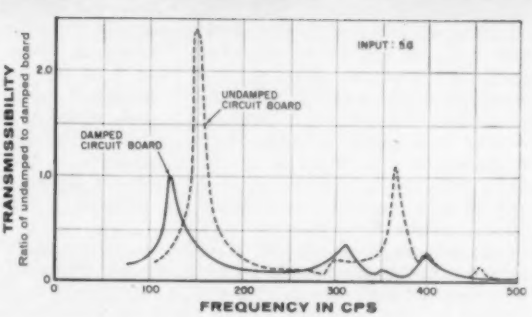
Printed Wiring for Industrial Service, Aug '56, p 167—Thorough evaluation of basic systems—etched, plated, embossed and pressed; properties of copper and silver conductors, and various insulating board materials; special problems presented in selecting components; design recommendations for base material, conductor size, prototype method, and hole drilling.

—Robert W Carson

NOW—BUILT-IN DAMPING FOR PRINTED CIRCUITS

R P THORPE, *supervisor, Electronics Group*
Lord Manufacturing Co, Erie, Penna





The printed circuit board here (top left) is a sandwich of two NEMA-G-11 epoxy-fiberglass laminates (copper-clad) filled with a viscoelastic material having high-damping characteristics over a range of temperatures from —65 to 250 F. Called Dynadamp Printed Circuit Board, this combination converts vibratory energy into shear strains that dissipate within the elastomer filler, thus damping the board. Typical decay rate traces at top right show the improved damping characteristics of the sandwich (lower trace) compared to an equal thickness of solid, undamped laminate. Built-in damping cuts resonant transmissibility as shown by test curves, at bottom, on a printed circuit with all electronic components mounted. Note that sharp reductions in transmissibility are accompanied by some shift in resonant points. Degree of transmissibility reduction depends on specific design and density of components.

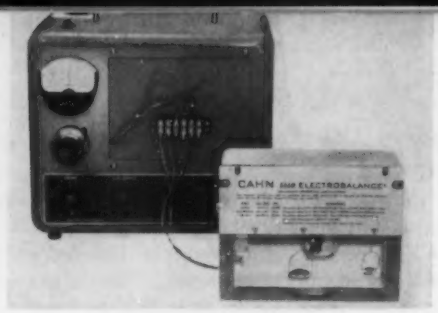
The new damped sandwich can be fabricated and processed by conventional printed circuit techniques. By reducing vibration amplitude and transmitted G-loads resulting from resonant responses over a wide frequency range, it is expected to improve reliability and reduce the size of many electronic packages.

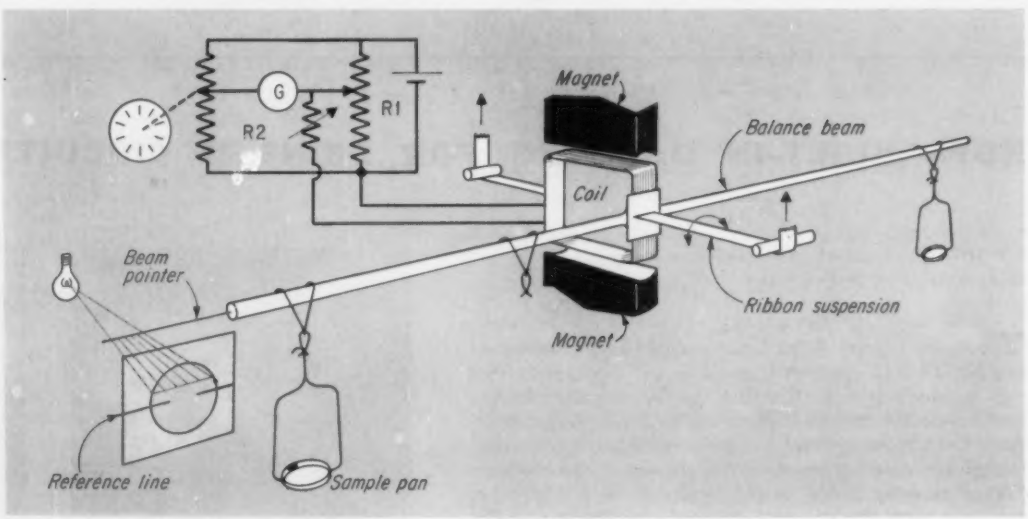
EDITOR'S NOTE: Look for a special report on high-damping materials for this, and other applications, in a forthcoming issue.

PRODUCT DESIGNS

Samples Weighed Electrically, Without Friction

Ribbon suspension of balance beam does away with bearing friction, is self-centering and needs no arresting mechanism. The instrument can be used for remote weighing in controlled atmosphere.

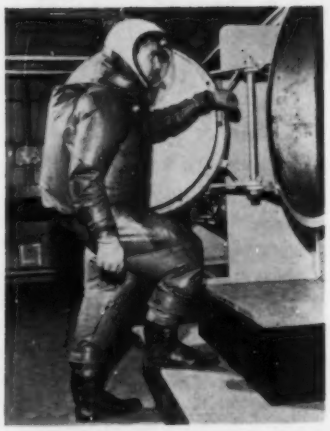




ELASTIC BEARING with zero hysteresis is achieved by use of metal-ribbon suspension system. Variations in ribbon rotational stiffness with temperature and age have no effect on balance reading. Suspension is self-centering and does not require an arresting mechanism. Beam is arrested to remove samples by driving it to the upper stop electrically (with R_1). Weight of sample is balanced by torque produced by current in the coil, which is suspended in a magnetic field. Since current is defined by Ampere's Law in terms of the force it exerts in a magnetic field, the balance is in theory perfectly linear. Coil and magnet design are matched to produce a torque exactly proportional to current.

Coil current is adjusted by R_1 until the electromagnetic torque balances the sample moment. This is indicated by alignment of the beam pointer with a reference line. Coil voltage is then measured by the precision potentiometer R_2 and galvanometer G. The dial on R_2 reads directly in milligrams or micrograms. A rheostat in series with R_2 provides front-panel calibration of the weight dial.

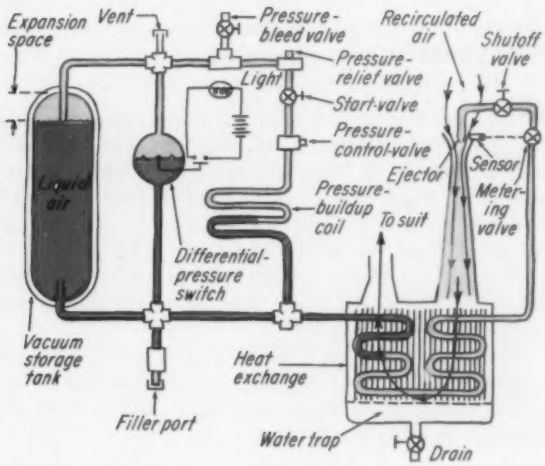
PS . . . Weighing chamber is an enclosed capsule, 6 x 8 x 3.75 in. over-all, which connects to the measuring assembly through 6 wires. The chamber can be turned 90° to measure horizontal forces. Eleven ranges, selected by panel switch and choice of loops, provide full-scale ranges from 0-1 mg to 0-1 gram. Accuracy is 0.001 mg on the lowest ranges, 0.05 of range on the higher ranges. Accuracy of 0.01% of range is possible with a special potentiometer. "Electrobalance" is produced in battery- or line-powered models by Cahn Instrument Co, Paramount, Calif.



Dressed for Oxygen Comfort

No outside connections are needed with this self-contained oxygen supplier. The liquefied-gas unit can be worn under protective clothing for safety in noxious or other hazardous atmospheres.

PS . . . Differential pressure (equivalent to ½ in. of water above ambient) holds airtight suit away from wearer's body—a safeguard against burn-through materials. Suit vent is located to trap exhaled CO_2. Filled pack weighs 16 lb; is 17 in. high, 12 in. wide, 5.25 in. deep; normally gives 1-hr supply. Circulation by strategically placed hoses gives max cooling capacity of 1100 btu/hr. Unit is produced by Garrett Corp, AiResearch Mfg Div, Los Angeles.



SOURCE OF OXYGEN is the high-vacuum bottle containing liquid oxygen or liquid air. This liquid goes in at —317 F through the filler port. Overflow at vent indicates full bottle. Some of the liquid vaporizes and raises pressure in the storage tank, which is limited to 170 psi by the relief valve.

Actually, heat transfer into the vacuum bottle would not be enough to maintain desired pressure in tank when the unit is in use. Therefore, the pressure-buildup coil is used to vaporize additional liquid. When the start-valve is opened, the additional pressure is fed from buildup coil to top of the storage tank. Pressure-closing valve is set to open at 148 psi and close at 150 psi to maintain desired operational pressure of approximately 149 psi at top of the tank. Pressure at base of tank is 149 psi plus weight of the liquid above it. When the difference in pressure drops to a predetermined value, the pressure-differential switch actuates a signal light which indicates that the user has a 10 to 14-minute supply remaining.

To start the unit, the operator opens the shutoff valve. This supplies the ejector nozzle with "primary air" (liquid from tank, which has been vaporized in passage through the heat exchanger). From the nozzle, the primary air is ejected into a venturi that acts as an aspirator pump, and is mixed with recirculated air from the compartment or suit being ventilated. The mixture then passes over the heat-exchanger coils for cooling before it is discharged into the suit or compartment.

A thermal sensor in the venturi inlet controls a proportioning valve that regulates the amount of primary air admitted to the nozzle. As the inlet temperature increases, primary airflow increases; as the temperature decreases, flow decreases. Primary airflow is maintained at a minimum to prevent carbon dioxide buildup, regardless of temperature.

BIRTH OF A PROJECT

A close look at the painful beginning and subsequent growth of an engineering organization, with special attention to the project engineer—midwife, hero, and scapegoat.

PETER L GARRETT, *Santa Monica, Calif*

From the first it is obvious to management that the real personnel problem is not who is needed but who can be spared. If there are no spare project leaders, you, the Right Man, are hired. Before you have had time to find out which requisition form to fill out for paper clips, you are presented with the Project. At that stage, the project consists of a delivery date, a selling price and a bar-chart schedule which started two weeks before you got the job.

Before I explain how the schedule came into being, I must explain how Management thinks. Despite appearances, managers do think—but in a unique way. For instance, they believe in man-hours.

The man-hour

A man-hour, like a foot-pound or a kilowatt-hour looks like a straightforward unit, but it isn't. A man-hour is an accounting unit of expense; it is equivalent to an average wage multiplied by time worked. This figure, multiplied by an overhead ratio, multiplied again by some number greater than 1 to take care of profit, gives one something like ten dollars an hour and simultaneously an insight into why the Germans and Japanese have such favorable balances of trade.

The tricky part of the man-hour is that it has a second simultaneous meaning. It is used to represent a definite part of the job to be done. The coordinates have been transformed. It is true that one man working for a thousand hours will "cost" 1000 man-hours (assuming an average pay scale)—the same amount that would be paid to 1000 men for one hour's work. But it is not true that 1000 men can do the same job. Only in very special situations, like building airstrips in China, can 1000 men do anything at all in one hour.

If, in a moment of irritation, you make this tedious point to some member of Management, you will not be contradicted. In fact, not a single one of the decision makers really believes that an accounting man-hour is really a job-completion man-hour. But the subtlety of the whole thing is that collectively, they act as though they did.

Only part of the mystery of how the schedule got that way can be explained by the absurdities of accounting. The rest of the explanation is buck fever. Buck fever is a twitching of the contract-signing fingers that assails corporate officers. Buck fever is especially severe after long, dry periods during which working capital dribbles away without doing any work. The fever is particularly infectious if the President is the carrier. In such a case, all the corporate officers may come down with the acute phase within minutes after contact. Under the dizzy influence of buck fever, corporate officers will let or even encourage the customer to assign the delivery date.

With the delivery date decided, much of the challenge of schedule making has disappeared. Working backward from delivery through qualification, assembly, subassembly, drafting, design and development, the overhead members of Engineering arrive (with varying degrees of compression) at the current date.

Now the announced reason for making the engineering department come up with a detailed schedule is that Management needs to plan other activities and to judge the week-to-week progress of the engineering department. In reality, the same people who make out the schedule report the progress and are thus able to suppress most of the discrepancies for long periods, but there is great psychological value in making each department fashion the club with which it will be beaten. The very process makes department heads twitch. Furthermore, it gives them a feeling of participation. Before two months have passed, they are going to be reminded of "their" promises. It all works out very much like a Russian treason trial.

Now that you have seen how the schedule came into being, you will appreciate that it is not considered sporting at all to challenge its reasonableness. The thing to do is look grave, impressed, but quietly optimistic and purposefully energetic. Your rfist task as Project Leader is to write a memo. Assuming that you're going to meet the schedule (For heaven's sake don't ever say that you are making such an assumption. When you lie, lie, don't quibble) . . . assuming that you're going to meet the schedule, and further, assuming that a man-hour is a man-hour, you make a generous estimate of the manpower requirements of the project.

There are several good reasons for this memo. First of all, it lays the groundwork for the memo war that may be fought later. Secondly, it puts Personnel on the spot; and the sooner you can get everybody else on

the fire with you, the better. Thirdly, it's just possible that you can get some people assigned to the project.

The state of the budget

Having studied the schedule and established your manpower requirements, you are now ready for the budget. If the company is small, and particularly if the financial picture would hang well beside an Albright, the budget is probably confidential. It remains, of course, as a lurking threat. But do not be disheartened; there are factors working for you.

It is safe to assume that the budget is just as silly as the schedule because it was created by applying man-hours to the schedule. However, if your schedule is really a horror, the chances are that even with a silly budget you cannot spend money fast enough to run out of it before you run out of time. For once, the man-hour confusion works for you.

The second reason to relax about the budget is Accounting. It will take Accounting four weeks at least to get organized. Even after they are organized, they will be consistently two weeks behind. If, by virtue of diligence and constant prodding, you can make your expenditures rise in a true exponential, you have Accounting defeated. First, they never know the current score; and second, they recognize only two functions: straight lines on ordinary paper, and straight lines on semi-log paper. (Very sophisticated accountants know about straight lines on log-log paper.) In any case, e^{at} will fox them every time, especially if alpha is large.

Having mastered the schedule, written your first memo, and overcome the fear of the budget, you are ready for the technical work of the project. You must understand the fundamental situation. You are responsible for all the technical decisions. This means that you must sign every drawing in the lower right-hand corner, including the circuit diagrams. Of course, by the time it comes to signing, all the important technical decisions have already been made. Still, you are in a key position to enforce your prejudices. You can toss your weight around by changing material, heat treatment and finishes. But beware of getting too deeply into questions of dimensions and tolerances. Arguing with checkers is like disciplining small children. They may not be very bright, but they are able and willing to spend 100% of their time outwitting you. Arguing with your designers is, of course, puerile. You are in bad enough trouble with the schedule as it is. And even if you are right, it is very doubtful that the change is worthwhile at this stage.

Administration

The really vital part of your job is to keep minute track of what everybody else is doing. At first glance, this may seem trivial; as a matter of fact, if your boss catches you keeping lists of drawings, change orders, inside vs outside procurement, etc., he is very likely to grumble. But stick to your guns. Within a matter of weeks, he'll come to you in a panic for just such a list as the one you are making.

By the time you are this far along, you will find that it was a very wise decision to avoid anything deeper than the most superficial brush with the more difficult technical problems. You have become an information center. You are vital to the functioning of the project not because you can analyze circuits or find the natural frequency of a three-degree-of-freedom system but because you can tell the job-shop draftsmen where the model shop is. It is simply amazing how many such questions arise in a single day.

If you eat your lunch from a paper bag, you will have a few minutes a day to think. During these quiet moments, it may strike you that you are not an engineer at all but a cross between a clerk and a receptionist. Do not become despondent; it's true. Your project needs its clerk-receptionist more than it does any of the engineers who really understand what the problem is supposed to be.

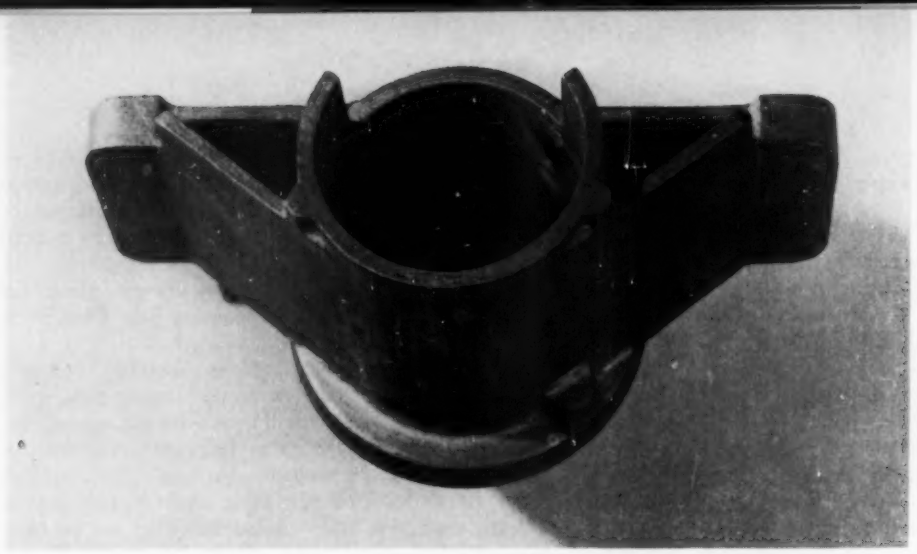
Every job begins on schedule, on budget, with a backlog of no mistakes whatever (with the possible exception of the signing of the contract). As time passes, the blue lines inch across the schedule. Inexorably, the date creeps ahead of the percent completion.

By the time the schedule is in obvious trouble, subterranean budgetary rumblings have begun. These can be ignored. Much more vexing is the problem of mistakes. The more work you have done, the larger is the backlog of mistakes. Change orders begin to float down the pipeline, not as isolated bits of paper, but as a steadily increasing proportion of the drafting output. Complaints come back to you from Production Control and Planning. Increasing requests are made for advance notice of pending change orders.

Don't do it! Perhaps the controlling reason for refusing to log change orders and distribute lists is that you haven't the foggiest notion of (a) why they are written, (b) how many there have been, or (c) how many there will be. Since Management neither scheduled nor budgeted any change orders, it is only vaguely aware that they exist. This entirely human disinclination to probe the depths should be tenderly cultivated. Never, under any circumstances whatever, permit any document to mention the total number that have been issued. (You can count on Accounting to have missed this boat, and don't worry about the time cards. There is no better hiding place for information than IBM cards that have been coded wrong.)

Your project is now barreling along at a rate that only a contract cancellation can stop. It would seem that your biggest trials are ahead of you, but they aren't. Whether or not you get through qualification depends on decisions made, many unconsciously, when the original proposal was written. You made your bet long ago; it remains now only to wait for the tote board to flash the results. The project has gained momentum and a subtle will of its own.

You, who gained a certain status from directing this torrent of effort and money, are beginning to realize that you are no longer the director. You have given birth to a rather frightening child, a child that still makes urgent demands but obeys only when it pleases. And with the birth of the child, you have become an adult; you have voluntarily taken personal responsibility for events over which you have no control. ■



Combined housing and mount was cast in plaster mold—a step in supplying complete working model of 12-v motor for buyer's tests.

plaster die gives

Accurate Prototypes for Diecastings

Make a wood pattern of the part to be produced, and from this a plaster mold. Then inject metal at low pressure and you have a reliable guide for pre-production tests. Speed and low tooling cost offset high cost per piece.

WILLIAM G NEWTON JR, *president*
Newton-New Haven Co, New Haven, Conn

When a design calls for diecastings, you can get a good preview of properties of the finished products by a short-run process that uses plaster molds.

The resulting prototypes improve designs for diecastings, and widen their field of application because design feasibility can be checked in the model stage. When metal is pressure-injected into a plaster mold, the flow pattern duplicates that of a production diecasting and gives similar properties and defects. These defects point out what changes are necessary to make the shape castable and eliminate need for later changes in the steel die. This shortens lead time for production.

In contrast, older methods which use static castings or machined pieces to simulate discastings do not give reliable test results, because prototype and final part do not have similar properties. Often, designs have to be changed at a late stage when converting to the production diecasting.

Plaster-die process

The prototype diecastings are made by pressure-injecting metal into a plaster "die." Tooling is inexpensive. A simple wood pattern is designed so that parting line and gating in the plaster mold are the same as those in the die used for production castings. Then the mold is poured in plaster, the pattern is removed, and the mold is baked. The cured plaster mold is now ready for casting. The "die" is closed by clamping the mold parts, and metal is injected into the cavity. Clamping pressures must be low because the plaster dies will not withstand normal pressures used in diecasting. Injection pressures are limited to less than 1/10 those used in diecasting, to avoid erosion of the plaster by the molten metal. After it's solidified, the casting is removed by breaking the expendable mold.

Properties of the prototypes

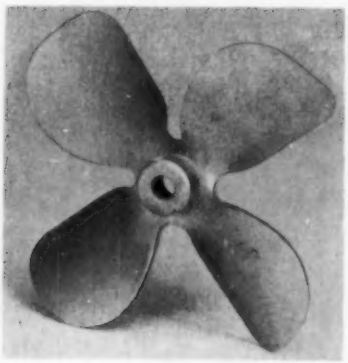
The cast-in-plaster versions have properties that closely approach those of final diecastings.

Strength distribution is similar because porosity and weak areas caused by airtraps or poor metal flow are frozen in the same location as in diecastings. Leakage under pressure will predict leakage location in the final casting.

Strength is slightly lower—about 80% that of a diecasting made in the same material—because parts cast in plaster do not have a die-chilled skin, which gives higher strength. However, strength is equal to or better than that of static castings. The lower strength in the prototype is a built-in safety factor—if this casting holds service loads, then the final diecasting will be a reliable part.

Dimensional stability is comparable. Cast in zinc, the plaster prototype and the production diecasting both grow dimensionally from internal metallurgical changes.

1



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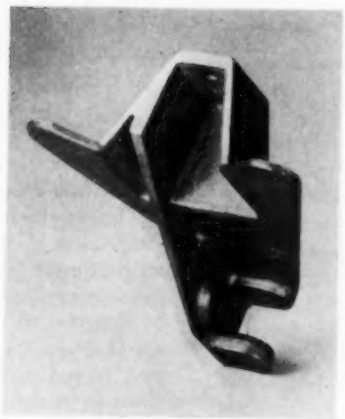


4

These prototypes were cast in plaster molds

1 . . Narrow groove and heavy bosses are innovations that proved feasible in this mixer housing.

2 . . Fan blades and hub cast in zinc passed mechanical tests. Formerly made from fabricated stamping, the diecasting requires no forming or assembly.

3 . . Mold for manufacturing brake lining was redesigned from a machined sand-casting. Prototype checked interchangeability of the new and old parts.

4 . . Low unit cost was not enough here. Structural bracket had to be checked for strength before die-cast part was approved for production.

Dimensional tolerances, however, must be larger—2 to 3 times those normally required for diecastings. Best tolerance here is 0.010 in., rather than the 0.003 to 0.005 in. used for diecastings.

Surface finish is rougher. No quantitative measurements have been taken but the plaster castings have a matte appearance, which requires buffing before applying decorative platings.

Surface details are readily reproduced. Fine lines, lettering and other decorative details can be included in the prototype. For example, a thin groove $\frac{1}{32}$ in. wide by $\frac{1}{8}$ in. deep is ordinarily difficult to produce in diecastings. But with this method the prototype shows it is feasible.

Inserts can be cast-in to check mechanical strength and to determine whether or not the inserts are practical.

Diecasting development

This technique is potentially capable of making any size diecasting in any die-casting alloy. We developed it initially to aid our own casting development and as a service to potential die-casting users. While we make only those prototypes that fit into our present die-casting production—150 to 200 sq in. at the parting line—the process is ideal for developing such large intricate diecastings as engine blocks which would require expensive tooling. Material in our castings is limited to our two production materials—the zinc alloy Zamak 3 and aluminum alloy A380—but almost any die-casting alloy can be used with the method.

EDITOR'S NOTE: Additional information on other short-run processes useful for prototype quantities:

Thermoforming + Investment Process = Ultrathin-wall Castings, Feb 27 '61, p 42—Economical technique developed for model nosecones, makes metal and plastic parts with walls as thin as 0.010 in.

Silicone Rubber Molds for Short-run Castings, Dec 26 '60, p 50—Article shows how room-temperature-vulcanizing silicone rubbers can be quickly turned into molds for casting metals or plastics.

Epoxy Parts Cast by Centrifugal Force, May 23 '60, p 45—How to get precision plastic parts in quantities that do not justify tooling costs of injection molding.

Short-run Blanking by the Rubber-die Process, Jan 25 '60, p 66—This method turns thin sheetmetal into complex shapes. It will handle runs of up to 500 parts or models for development work.

Cheaper Prototypes from One-shot Investment Castings, Jan 4 '60, p 55—Plaster molds made by lost-wax method and low-melting-point alloys provide a cheap, quick way to visualize a cast part before production.

Speed Your New Product with Cast Epoxy Models, Dec 21 '59, p 60—Casting technique allows simultaneous appraisal of many designs by key departments — engineering, production and sales.

—Herbert Kee

the yo-yo despinner . . .

NEW MECHANISM STOPS SPIN OF ROTATING MASSES

It changes the geometric configuration of a spinning body by letting two small connected masses unwind from it. That's all there is to it—but it can stop a large mass, spinning at high speed, in a fraction of a second.

MERL D CREECH, *professor of mechanical engineering*
RICHARD K FERGIN, *graduate assistant, Physical Science Laboratory*
New Mexico State University
University Park, NM

How can you instantly and inexpensively stop the spin of a high-speed rotating mass—such as a gas turbine rotor—in an emergency? A problem faced in stopping the spin of a space vehicle in flight has brought a solution to this general problem. This answer is a device unofficially dubbed the "yo-yo despinner." It will be installed on the Navy's Hugo III photographic-reconnaissance rocket, scheduled for its first trial shot in the near future. Its job will be to stop the spin of Hugo's payload, allowing high-resolution photos during flight. Tests prove the spin of the space vehicle can be "braked" to dead stop within a fraction of a second.

The device does its job by releasing two small diametrically opposed weights that are connected by cords (actually, Hugo will use flexible metal tapes) to the spinning body, Fig 1. This transfers the total angular momentum of the spinning mass to the two weights—which are automatically jettisoned at the end of the unwinding cycle.

Remarkable features of this device are:

- Once the proper weights and cord length have been selected for the spinning mass, release of the weights will stop the spinning no matter what the initial speed —1 rpm or 100,000 rpm.
- The faster the spin, the quicker will be the stop.
- Braking is smooth—the spinning mass is not jerked to a stop. There is no rebound.
- The device can be designed to cause the spinning mass to reverse its direction of rotation—to a predetermined reverse-spin velocity.
- Tolerances on cord length and weights are fairly liberal to obtain desired results.

HOW IT WORKS

Here's how the yo-yo stops spin: The weights are released and allowed to unwind from the spinning cylindrical section, Fig 2 (only one of the two weights is shown in this illustration). Path of the weight relative to the cylinder is a circular involute, from point A to point *B*. At point *B*, the cord is tangential to the point of attachment, point *P*. From point *B* to point *B′*, the weight follows a circular path, pivoting about point *P*.

The system can be designed to stop the spin when the weights are at the end of the involute path, *B*. But the weights must be dropped off when the spin stops, and this is complicated at point *B*. However, the system can be designed so that spin doesn't stop until the weights are at *B′* on the circular path; if the cords are retained only by a slot, they will fly free at the right instant—when the weight is in line with OP.

If the weights are not released at the proper time, the tension in the cord would cause the central body to have an angular acceleration in the direction of its initial spin. This acceleration would continue until the cords were fully wound in the opposite direction, at which time the angular velocity of the system would be the same as the initial rate. Following this instant, the small weights would unwind in straight lines tangential to the central cylinder and start a recycling process.

Although the application of this principle is new, the Jet Propulsion Laboratory of California Institute of Technology used a similar method in 1958 for despin of NASA's Pioneer IV. They furnished us their mathematical derivations for our development work; however, our derivations, which are presented here, differ from those of JPL. Ours clearly show that to stop spin, the cord length and size of weights are independent of the initial spin rate.

Two sets of equations have been developed—the first set is for the case where despinning occurs at end of the involute path (tangential release of the weights); the second set is for the case where despinning occurs at end of the circular path (radial release). In addition to the laws of conservation of energy and of momentum, our derivations make use of the relative-velocity theorem. A numerical problem is included to illustrate use of the equations.

DESIGNING FOR TANGENTIAL RELEASE

The moment of momentum and the kinetic energy of the system remain constant, and the two simultaneous

1 . . THREE STAGES OF DESPIN: (A) Spin velocity, ω_1, constant; two weights held in place. (B) Weights have been released and have begun to unwrap; spin velocity has slowed. (C) Spin velocity is zero; weights and cords fly out of slots. Photo shows test model.

equations relating these factors to the geometric configuration of the system have been solved for the angular velocity of the central rotating body as a function of time.

It is assumed the stiffness and the mass of the cord connecting the small masses to the central rotating body can be neglected (this has been verified by tests). Also, the small masses are considered to be particles moving in a plane perpendicular to the axis of rotation of the central rotating cylinder.

The mathematical model for which the equations are written is shown in Fig 2. At time t after their release, the mass particles have moved to point C. During this interval the cylindrical section has rotated through angle θ. Thus the mass particles are moving along involute paths fixed to and rotating with the cylinder.

Moment of momentum H of the system about the axis of the cylinder is (see symbols):

$$H = I\theta' + 2m\rho^2\phi' \tag{1}$$

where the prime mark denotes first derivative with respect to time. Kinetic energy KE of the system is:

$$KE = \frac{I(\theta')^2}{2} + m\rho^2(\phi')^2 + m(\rho')^2 \tag{2}$$

To solve Eq (1) and (2) simultaneously, some of the geometrical properties of the involute must be employed. From Fig 2,

$$\phi = \theta + \beta - \psi \tag{3}$$

The time derivative of Eq (3) is:

$$\phi' = \theta' + \beta' - \psi' \tag{4}$$

$$\text{Also, } \tan\psi = \frac{R}{a} = \frac{\text{arc length } DA}{a} = \beta \tag{5}$$

$$\text{therefore } \psi = \tan^{-1}\beta \tag{5A}$$

Differentiating with respect to time:

$$\psi' = \frac{\beta'}{1+\beta^2} \tag{6}$$

Substituting this relationship into Eq (4):

$$\phi' = \theta' + \frac{\beta^2}{1+\beta^2}\beta' \tag{7}$$

It is now necessary to use the velocity of the mass particle relative to point C fixed to the path and coincident with it at the instant under consideration. By the relative-velocity theorem:

$$V_m = V_c + V_{m/c} \tag{8}$$

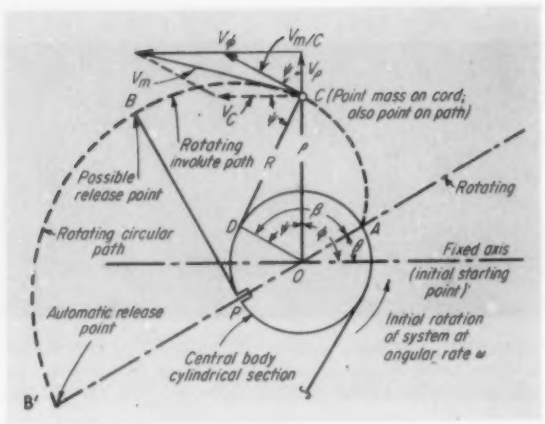
where the plus sign here denotes vectoral addition. V_m, the absolute velocity of the mass particle at time t, can be resolved into radial and tangential components:

$$V_\rho = \rho'; V_\phi = \rho\phi' \tag{9}$$

Because the center of curvature of point C of the involute path is at D, the cord connecting the small mass to the cylinder is normal to the involute. Consequently, the velocity $V_{m/c}$ of the mass particle relative to its coincident point C on the involute path is perpendicular

SYMBOLS

a	= Radius of central-body cylindrical section, ft
A	= Absolute acceleration, ft/sec^2
A_ρ	= Absolute radial component of acceleration
A_ϕ	= Absolute tangential component of acceleration
H	= Angular momentum, slug-ft^2/sec
I	= Centroidal mass moment of inertia of central body about spin axis, slug-ft^2
KE	= Kinetic energy, ft-lb
m	= Point mass and mass of point mass, slugs
R	= Length of unwound cord or metal tape, ft
t	= Elapsed time from initial start, sec
T	= Tension in cord, lb
V_c	= Velocity of point c on rotating path, ft/sec
V_m	= Absolute velocity of point mass, ft/sec
V_m/C	= Velocity of m relative to c, ft/sec
V_ρ	= Absolute radial component of velocity
V_ϕ	= Absolute tangential component of velocity
β	= Angular displacement of tangent point of unwound cord relative to rotating axis, radians
θ	= Angular displacement of central body relative to fixed axis, radians
θ'	= Spin velocity, radians/sec
ψ	= $(\beta + \theta - \phi)$, additional angle used for solution
ω	= θ' at $t = 0$ (initial spin velocity), radians/sec



2 . . UNWINDING WEIGHT follows an involute, then circular path. Release is automatic at B', but despin mechanism can be designed to stop spin of central mass when weight is at B.

to CD. Therefore:

$$V_\rho = \rho' = V_{m/c} \cos \psi \tag{10}$$

$$\text{but } \frac{a}{\rho} = \cos \psi \tag{11}$$

$$\text{and } V_{m/c} = R\beta' = a\beta\beta' \tag{12}$$

Combining Eq (10), (11) and (12)

$$\rho = a\beta\beta' \cos \psi \tag{13}$$

$$\rho' = \frac{a^2\beta\beta'}{\rho} \tag{14}$$

Also from the geometry of the system, Fig 2:

$$\rho^2 = (a\beta)^2 + a^2 = a^2 (1 + \beta^2) \tag{15}$$

Substituting the relationships for ρ^2 of Eq (15) and ϕ' of Eq (7) into Eq (1):

$$H = I\theta' + 2\,ma^2 [\beta^2(\theta' + \beta') + \theta'] \tag{16}$$

Moment of momentum of the system H remains constant and $\beta = 0$ at $t = 0$. Letting $\theta' = \omega$ at $t = 0$, the constant value of H is:

$$H = (I + 2\,ma^2)\,\omega \tag{17}$$

Therefore, Eq (16) may be written:

$$(I + 2\,ma^2)\,\omega = I\theta' + 2\,ma^2 [\beta^2(\theta' + \beta') + \theta'] \tag{18}$$

From Eq (14) and (15):

$$(\rho')^2 = \frac{a^2\beta^2(\beta')^2}{1 + \beta^2} \tag{19}$$

Substituting the relationships for $(\rho')^2$ of Eq (19), ρ^2 of Eq (15) and ϕ' of Eq (7) into Eq (2):

$$KE = \frac{I(\theta')^2}{2} + ma^2[(\theta')^2 + \beta^2(\theta' + \beta')^2] \tag{20}$$

Likewise system kinetic energy KE remains constant and $\beta = 0$ at $t = 0$. Letting $\theta' = \omega$ at $t = 0$, the constant value of KE from Eq (20) is:

$$KE = (I + 2\,ma^2)\,\frac{\omega^2}{2} \tag{21}$$

Therefore, Eq (20) may be written:

$$(I + 2\,ma^2)\,\frac{\omega^2}{2} = \frac{I(\theta')^2}{2} + ma^2[(\theta')^2 + \beta^2(\theta' + \beta')^2] \tag{22}$$

Subtracting Eq (18) from Eq (22) and simplifying:

$$\beta' = \omega. \tag{23}$$

This shows the angular rate of unwinding relative to the central body is constant. Integrating Eq (23), and setting $\beta = 0$ at $t = 0$:

$$\beta = \omega t \tag{24}$$

Substituting for β' and β into previous pertinent equations gives these important velocity relationships:

$$\theta' = \left[\frac{I + 2\,ma^2 - 2\,ma^2\,\omega^2\,t^2}{I + 2\,ma^2 + 2\,ma^2\,\omega^2\,t^2}\right]\omega \tag{25}$$

$$\phi' = \left[\frac{1 + 2\,ma^2 + 2\,ma^2\,\omega^2\,t^2 + 2\,I\omega^2\,t^2}{(I + 2\,ma^2 + 2\,ma^2\,\omega^2\,t^2)\,(1 + \omega^2\,t^2)}\right]\omega \tag{26}$$

$$\psi' = \frac{\omega}{1 + \omega^2\,t^2} \tag{27}$$

$$\rho' = \frac{a\omega^2\,t}{(1 + \omega^2\,t^2)^{1/2}} \tag{28}$$

$$\rho = a(1 + \omega^2\,t^2)^{1/2} \tag{29}$$

$$\psi = \tan^{-1}\omega t \tag{30}$$

Integrating Eq (25), setting $\theta' = \omega$ at $t = 0$:

$$\theta = 2\left[\frac{I + 2\,ma^2}{2\,ma^2}\right]\tan^{-1}\left[\frac{2\,ma^2\,\omega^2\,t^2}{I + 2\,ma^2}\right]^{1/2} - \omega t \tag{31}$$

Substituting the relationships for β, ψ and θ into Eq (3):

$$\phi = 2\left[\frac{I + 2\,ma^2}{2\,ma^2}\right]\tan^{-1}\left[\frac{2\,ma^2\,\omega^2\,t^2}{I + 2\,ma^2}\right]^{1/2} - \tan^{-1}\,\omega t \tag{32}$$

For the calculation of cord tension T, accelerations are used for determining reverse effective forces. The double prime mark denotes second derivative:

$$A_\rho = \rho'' - \rho(\phi')^2 \tag{33}$$

$$\text{and } A_\phi = 2\,\rho'\phi' + \rho\phi'' \tag{34}$$

Equations of equilibrium using reverse effective forces are:

$$mA_\rho = T \sin \psi;\; mA_\phi = T \cos \psi \tag{35}$$

or substituting the relationship for $A\rho$ and solving for T:

$$T = \frac{m}{\sin \psi}\,(\rho'' - \rho(\phi')^2) \tag{36}$$

$$\text{and } T = \frac{m}{\cos \psi}\,(2\,\rho'\phi' + \rho\phi'') \tag{37}$$

An alternate relationship, since the acceleration of the central body is proportional to torque, is:

$$2\,Ta = I\theta''$$

$$\text{or } T = \frac{I\theta''}{2\,a} \tag{38}$$

Differentiating Eq (25), (26) and (28)

$$\theta'' = \frac{-4\,(I + 2\,ma^2)\,(2\,ma^2\,\omega^2)\,\omega t}{(I + 2\,ma^2 + 2\,ma^2\,\omega^2\,t^2)^2} \tag{39}$$

$$\phi'' = \left[\frac{-8\,ma^2\,\omega^2\,t\,(I + 2\,ma^2)}{(I + 2\,ma^2 + 2\,ma^2\,\omega^2\,t^2)^2} + \frac{2\,\omega^2\,t}{(1 + \omega^2\,t^2)^2}\right]\omega \tag{40}$$

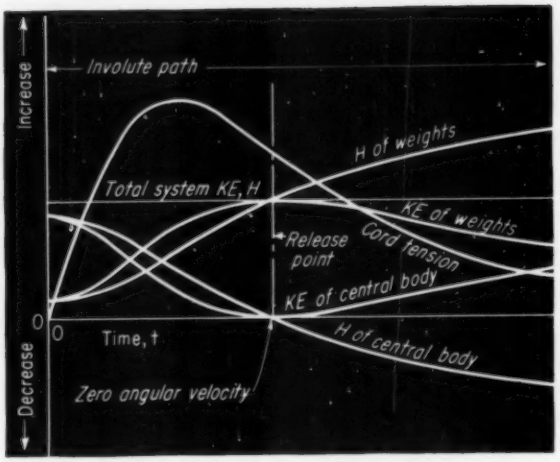
$$\rho'' = \frac{a\omega^2}{(1 + \omega^2\,t^2)^{3/2}} \tag{41}$$

Substituting the relationship for ρ of Eq (29) into Eq (11)

$$\cos \psi = \frac{1}{(1 + \omega^2\,t^2)^{1/2}} \tag{42}$$

From the geometry of the system, Fig 2:

$$\sin \psi = \frac{R}{\rho} \tag{43}$$



3 . . VARIATIONS in angular momentum H, kinetic energy KE, and cord tension during despin.

then, combining Eq (24), (5) and (43)

$$\sin \psi = \frac{\omega t}{(1 + \omega^2 t^2)^{1/2}} \tag{44}$$

Substituting the relationships for sin ψ of Eq (44), ρ'' of Eq (41), ρ of Eq (29), and ϕ' of Eq (26) into Eq (36)

$$T = \frac{(I + 2ma^2)(4Ima\,\omega^2 t)}{(I + 2ma^2 + 2ma^2\,\omega^2 t^2)^2} \tag{45}$$

For maximum cord tension T, Eq (45) is differentiated with respect to time and T' set equal to zero. Then solving for time t at maximum T

$$t_{T\max} = \left[\frac{I + 2ma^2}{6ma^2\,\omega^2}\right]^{1/2} \tag{46}$$

Substituting into Eq (45) gives maximum cord tension

$$T_{\max} = \frac{3I\omega^2}{4}\left[\frac{3m}{2(I + 2ma^2)}\right]^{1/2} \tag{47}$$

Substituting for β of Eq (24) into Eq (5)

$$R = a\omega t \tag{48}$$

Setting $\theta' = 0$ in Eq (25) and solving for t gives the elapsed time to stop the central body:

$$t_{\theta'=0} = \left[\frac{I + 2ma^2}{2ma^2\,\omega^2}\right]^{1/2} \tag{49}$$

Substituting this value into Eq (48) gives the required length of cord to be unwound tangentially from the cylinder to cause the central body to stop its spin

$$R_{\theta'=0} = \left[\frac{I + 2ma^2}{2m}\right]^{1/2} \tag{50}$$

Final spin velocity for other cord lengths, from Eq (25) and (48)

$$\theta' = \left[\frac{I + 2ma^2 - 2mR^2}{I + 2ma^2 + 2mR^2}\right]\omega \tag{51}$$

Eq (50) shows that the length of cord required to unwind tangentially to despin the central body is a function only of the initial mass configuration of the system. Hence we can design despin mechanisms completely self-contained and self-actuated—independent of the initial spin rate of the system. Also of interest: the faster the initial spin rate, the faster the despin occurs.

NUMERICAL PROBLEM—INVOLUTE PATH

m = 2.07 lb_m = 0.0643 slug (where lb_m is lb-mass); M = mass of central body = 40 lb_m; K = radius of gyration of central body = 0.219 ft.; a = 0.279 ft.; $\omega = 20\pi$ rad/sec

from which $I = MK^2/g$ = 0.06 slug-ft²

and $2ma^2$ = 0.01 slug-ft²

CALCULATIONS

Using Eq (47) for maximum cord tension:

$$T_{\max} = \frac{(3)(0.06\text{ slug-ft}^2)(20\pi)^2}{(4)(\text{sec}^2)} \times \left[\frac{(3)(0.0643\text{ slug})}{(2)(0.06 + 0.01)(\text{slug-ft}^2)}\right]^{1/2}$$

$T_{\max}$ = 208.5 lb force

Using Eq (49) for the elapsed time t for the central body to stop spinning:

$$t_{\theta'=0} = \left[\frac{(0.06 + 0.01)(\text{slug-ft}^2\text{-sec}^2)}{(0.01)(\text{slug-ft}^2)(20\pi)^2}\right]^{1/2} = 0.042\text{ sec}$$

Using Eq (50) for the required length of cord to be unwound tangentially from the cylinder to cause the central-body spin to decrease to zero:

$$R_{\theta'=0} = \left[\frac{0.06 + 0.01}{2(0.0643)}\right]^{1/2} = 0.739\text{ ft}$$

DESIGNING FOR RADIAL RELEASE

Despin-mechanism design is simplified by allowing the weights to continue their motion until the cords are extended radially outward from the central body. This also allows looser tolerances of the component parts. The equation for the required length of cord to produce zero spin velocity at the end of the circular path has been derived as:

$$R_{\theta'=0} = \left[\frac{I + 2ma^2}{2m}\right]^{1/2} - a \tag{52}$$

This equation shows the same independence of initial spin velocity as does Eq (50). A comparison shows that for radial release, the cord length is reduced by an amount equal to the radius of the central body.

ALLOWABLE TOLERANCES

The effect of tolerances on cord length, despin masses and moment of inertia of central body can be computed from:

$$\theta' \approx \frac{I + 2ma^2 - 2m(R + a)^2}{I + 2ma^2 + 2m(R + a)^2}\,\omega \tag{53}$$

Thus, by giving θ' its maximum or minimum allowable value, the allowable tolerances for component parts can be approximated.

For REPRINT of above article, just check 597 on one of the Reader Service cards bound in this issue.

EDITOR'S NOTE: For other methods of stopping a spinning mass or limiting its speed see:

How to Select Electromagnetic Clutches and Brakes for Automatic Control, Dec 19 '60, p 29—Design information on magnetic-friction, purely magnetic and particle clutches and brakes.

—Nicholas Chironis

CHECKLIST FOR PLANETARY-GEAR SETS

These five tests quickly tell whether the gears will mesh, and whether there is room for them to fit together.

HUGH P HUBBARD, *mechanical engineer*
Seattle, Wash

SYMBOLS

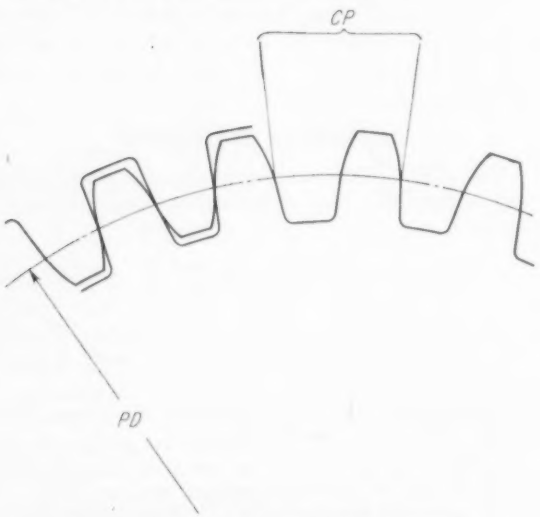
CP	= Circular pitch, in.
L	= Distance from center of sun gear to center of planet gear, in.
M	= Major or outside diameter of gear, in.
DP	= Diametral pitch, teeth/in.
m	= Minor, or working depth diameter of gear, in.
N	= Number of teeth per gear
PD	= Pitch diameter, in.
x	= The whole number in dividend when N_s is divided by number of planets
y	= The whole number in dividend when N_r is divided by number of planets
z	= Increment for locating planet gear
α	= Angular location of planet gear

You have decided to design a planetary-gear system with a certain gear ratio, and have chosen the number of teeth for each gear to get that ratio. Will it work? Will the gears fit together to make a workable system?

If they can pass the following five tests, they will.

1—Do all gears have the same circular pitch?

If they do not, the gears will not mesh.



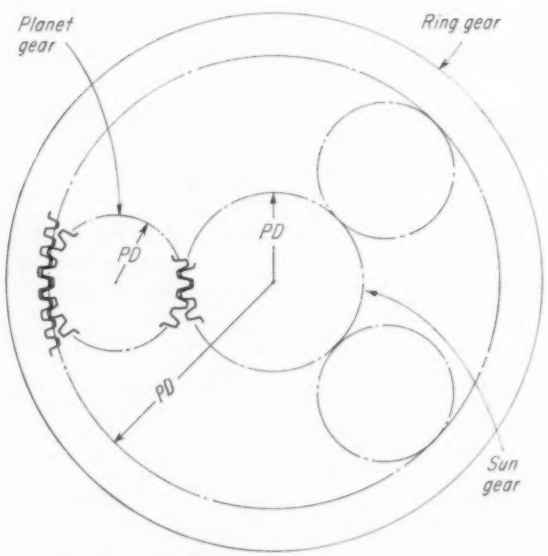
Circular pitch $CP = \pi/DP = PD/N$

Circular pitch and number of teeth determine pitch diameter, which leads to the next test:

2—Will the gears mate at the pitch diameters?

This equation shows whether the planet gear will fill the space between the sun gear and the ring gear:

$$N_p = \frac{N_r - N_s}{2}$$



3—Will the teeth mesh?

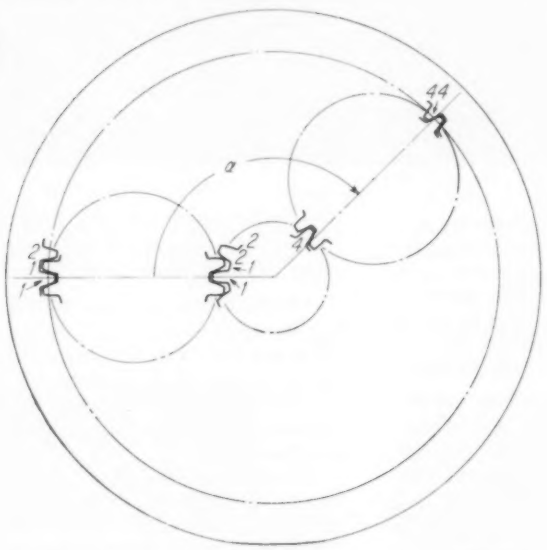
Gears that pass the first two tests will not necessarily pass this one. If the gears have the wrong number of

teeth, the planet gear will not mesh with the sun gear and the ring gear at the same time. Gears with numbers of teeth divisible by three will mesh. There are two other possible cases.

Case I—The number of teeth on the sun gear divides evenly into the number of teeth on the ring gear. This set will mesh, if allowance is made by spacing the planet gears unevenly around the sun gear.

EXAMPLE: In a set of planetary gears the ring gear has 70 teeth, the sun gear 14 teeth and each of the three planet gears 28 teeth. Even spacing would place the planet gears every 120°, but in this case they must be placed slightly to one side of the 120° point to mesh. Since N_s divides evenly into N_r there is a tooth on the ring gear opposite every tooth on the sun gear. Therefore, it is possible to fit a planet gear opposite any tooth on the sun gear. Tooth 6, five circular pitches from tooth 1, is the choice because it is closest to being one-third of the way around. It is opposite tooth 26 on the ring gear, because Nr/Ns = 70/14 = 25/5.

Case II—The number of teeth on the sun gear does not divide evenly into the number of teeth on the ring gear. This set may or may not mesh; the following example shows how to tell.



EXAMPLE: In a set of planetary gears with three planets, the ring gear has 134 teeth, the sun gear 14 and the planet gears 60 each. $N_s/3 = 14/3 = 4.67$, so the whole number $x = 4$. $N_r/3 = 134/3 = 44.67$, so the whole number $y = 44$.

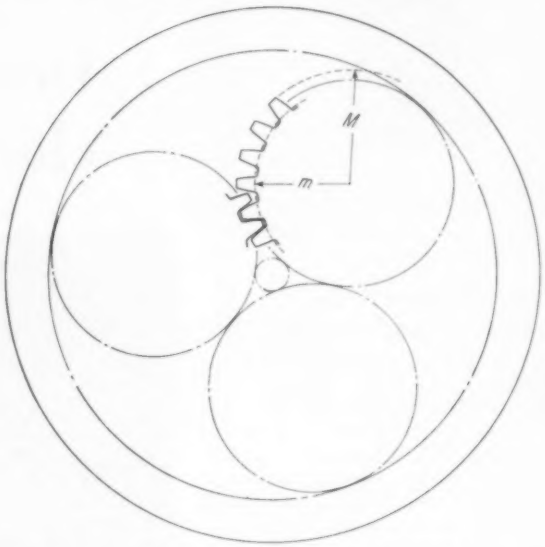
Plug these numbers into the locating equation

$$(x+z)\,N_r/N_s = y+(1-z) = (4+z)\,134/14 = 44+(1-z)$$
$$10.57\,z = 6.72$$
$$z = 0.636$$

Location of the planet gear as a fractional part of the circular distance around the set is $(x + z)/N_s = 4.636/14 = 0.3311$, and $y + (1 - z)/N_r = 44.364/134 = 0.3311$. The answers agree to four places, so the gears will mesh. If the answers don't agree to four places, there will be interference.

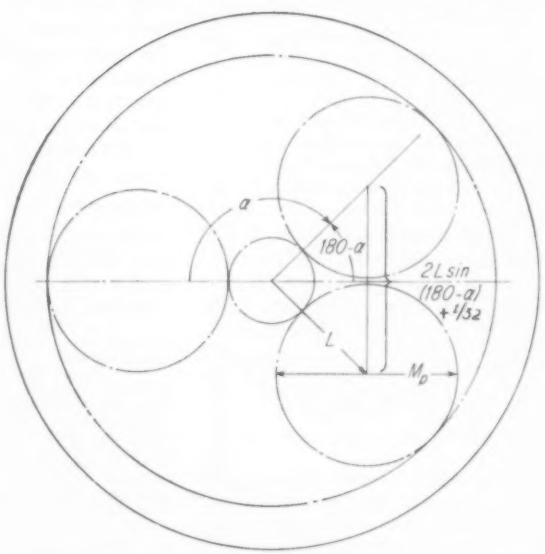
Angle $a = 0.3311 \times 360 = 119.2°$

4—Can three planets fit around the sun gear?



They will if the major diameters adhere to the limitation $M_p + m_s/2 < m_r$ by a safety clearance of 1/32 in. more than maximum tolerances.

5—Will irregularly spaced planets hit each other?



Two adjacent planets will not hit each other if $2L \sin (180 - a) > M_p + 1/32$ in. safety clearance. Sun-to-planet center-to-center distance $L = (PD_s + PD_p)/2$. ■

RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By Fred E. Graves

Fastening of joints in corrosive environment

For a fastener to stand up in a corrosive environment it must either be coated, or made from an anti-corrosive metal.

THE METALLIC COATINGS

The "workhorse" applications are satisfied most economically with SAE Grade 2 or Grade 5 fasteners. Required outdoor durability is achieved with a plated or a hot galvanized finish. Hot galvanizing complicates good thread fits, costs more than plating in the popular size range, but gives much greater protection than any commercial plating.

A heavy galvanized coating is not recommended on highly stressed fasteners. If you need the high strength of Grade 5 bolts and want them corrosion-resistant, zinc plating should be your first choice. Certain conditions may require cadmium, nickel or copper plate.

THE ENDURING METALS

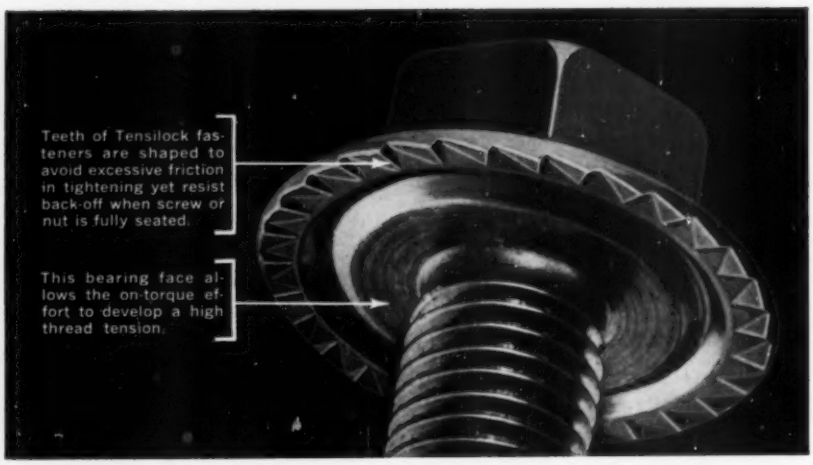
While each metal poses problems in certain applications, stainless steel, aluminum, and silicon bronze all offer distinct advantages.

Silicon bronze is popular for electrical uses due to its unusual strength, resistance to stress-corrosion, good conductivity.

Aluminum fasteners afford light weight as well as excellent conductivity. Anodized, they provide various colors; better corrosion resistance.

Widely used for fasteners, the 18-8 grade stainless steel assures good strength and excellent corrosion resistance in most atmospheres.

How Tensilock® Screws clamp tight, lock tight


Teeth of Tensilock fasteners are shaped to avoid excessive friction in tightening yet resist back-off when screw or nut is fully seated.
This bearing face allows the on-torque effort to develop a high thread tension.

TENSILOCK screws belong in the same league as high strength hex screws. With the same on-torque effort, the Tensilock units develop about 90% of the thread tension usually developed by the latter. Thus, they *both* make strong joints.

THREAD TENSION = CLAMPING FORCE

In theory, the higher the thread tension, the stronger the joint and the higher the inherent ability of the fastener to stay tight. In practice, you derive these benefits by torquing a high strength screw close to its *yield strength*. But what if you need high thread tension plus *extra* assurance that joints will stay tight? Then you have a job for Tensilock units. Not only do they develop the high thread tension, but also have an extra (and *integral*) locking device.

Screw Diameter		¼	⅜	½
Thread Tension (lbs.)	Tensilock	2,750	6,750	12,400
	High Strength Hex	2,975	7,250	13,300
On Torque (inch lbs.)	Both	120	420	1,000
Off Torque (inch lbs.)	Tensilock	150	525	1,250
	High Strength Hex	95	330	800

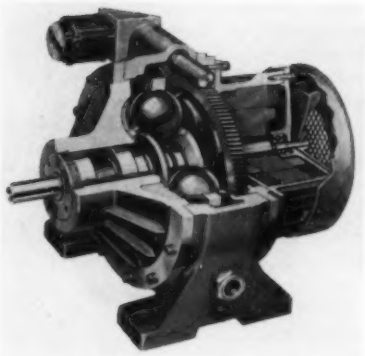
OFF-TORQUE = LOCKING POWER

By design, loosening torque of Tensilock fasteners exceeds tightening torque by 25% or more. This is an effective "lock." It gives that extra margin of safety against vibratory loosening.

To sum up: RB&W's Tensilock screws are stronger than Low Carbon Hex Screws; compare with High Strength Hex Screws in clamping force; are superior to them in locking action. Suggestion: For a strong locking *bolt*, use with Tensilock Nut. Send for Bulletin TL-2. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Sales office and warehouse at: San Francisco, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas.

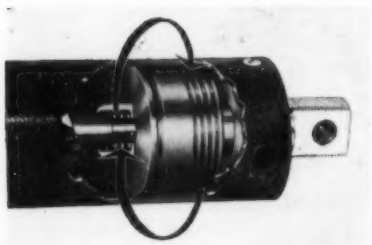
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES



Variable-speed drive . . .

with integral "pancake" style motor, uses rolling action of a series of balls for smooth adjustment of output speed (in 9:1 and 6:1 ranges) while operating under load. Power is transmitted through input shaft to beveled drive disk in contact with axle-mounted alloy-steel drive balls. Input-shaft rotation causes balls to rotate about their axles, which in turn transmits power to output shaft (through similar ball-disk contact). By tilting both axles and balls, relative lengths of contact paths on input and output sides of the balls are varied to give increasing or decreasing ratios. Variator is available in ¼ to 15-hp. sizes. Motor is ac radial-airgap unit, **Cleveland Worm & Gear Div, Eaton Mfg Co, 3300 E 80th St, Cleveland 4.**

Circle 300 on Reader Service Card



Adjustable-stroke cylinder . . .

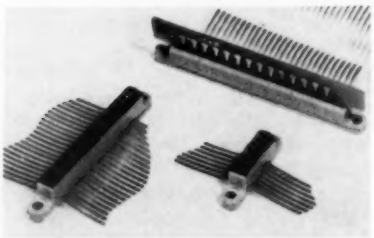
has series of $\frac{1}{16}$-in.-thick spacing washers to position piston on piston rod and change stroke length. Unit is made with stock stroke lengths in increments of 1 in. By removing front spacing washers and adding corresponding number of rear spacing washers, stroke length can be reduced without disturbing mounting dimensions. **Modernair Corp, 400 Preda St, San Leandro, Calif.**

Circle 301 on Reader Service Card

Aluminum pulley stock . . .

is available in 8-in. lengths that can be cut to any size for use with US Rubber's timing belts. The ½-in. pitch stock is supplied with from 10 to 36 grooves and with pitch diameters from 0.637 to 2.292. Suitable for research and development departments and for users requiring nonstandard-size timing-belt drives. Prices range from $6.50 to $21.60. **H Neuman & Co, 8136 N Lawndale Ave, Skokie, Ill.**

Circle 302 on Reader Service Card



Printed circuit connector . . .

produces direct conductor-to-conductor contact without solder. Continuous one-piece spring locks cable into connector and provides a pressure point at each conductor contact. Device for connecting flat conductor cable to printed circuit boards or to flexible etched circuitry also is suitable for setting up test points at any position on flat conductor cable or for connecting cable to other cable without cutting conductors. **Thomas & Betts Co, 36 Butler St, Elizabeth, NJ.**

Circle 303 on Reader Service Card

Heavy current switching relay

has two ¼-in. silver-tungsten contacts mounted on a bar which is assembled to modified armature by means of a bar spring. When armature operates, contact bar is free to "rock" on spring. This equalizes contact pressures as two movable contacts engage two stationary contacts creating a series circuit (through one stationary spring, one pair of contacts, contact bar, another pair of contacts and other stationary spring). Relay is rated for 25 amps and 24-v carrying capacity. Tests, however, indicate that it may be capable of carrying a resistive load of up to 60 amps at 28 v dc for as much as 50,000 operations or more with a moderate duty cycle. Priced at $7.50 in small quantities. Delivery in 45 to 60 days. **Automatic Electric Co, 400 N Wolf Rd, Northlake, Ill.**

Circle 304 on Reader Service Card

Stainless steel foil . . .

is self-adhesive and reportedly increases adhesive strength after 60-hr immersion in 75-F water. The 0.003-in. stainless steel foil can be applied to almost any clean, smooth, dry surface. Initial-contact adhesion ranges from 2 to 4 lb per in. with buildup in strength of 60 to 75% or more during first three days. Said to be effective from —50 to 300 F and to have a shelf-life of approx 2 yr. **Fasson Products Div, Avery Adhesive Products Inc, 250 Chester St, Painesville, Ohio.**

Circle 305 on Reader Service Card

Columbium-treated steel . . .

with copper additive (0.20 min) has almost twice the atmospheric corrosion resistance of mild carbon steel and equal that of some high strength, low alloy proprietary grades. Available in four copper bearing grades with min yields of 45,000, 50,000, 55,000 and 60,000 psi. Gages and sizes approximate that of Jalten, a high strength, low alloy grade. Supplied in plates up to ⅜ in. inclusive; in both hot-rolled and cold-rolled sheets; and in hot-rolled bars, small shapes and structural shapes of limited range. **Jones & Laughlin Steel Corp, 3 Gateway Center, Pittsburgh 30.**

Circle 306 on Reader Service Card

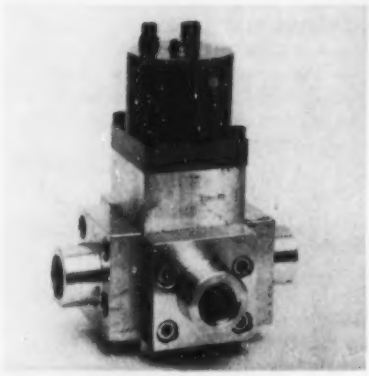
Alloy for aluminum castings

with tensile strengths up to 50,000 psi, contains silicon and magnesium with small addition of beryllium. Allows castings to be made under normal foundry conditions and is suitable for applications requiring high strength with low weight. Can be cast in both sand and permanent

continued on page 64

molds without special tooling. High fluidity permits wall thicknesses of ⅛ in. to be cast in sand and 3/32 in. in permanent molds. Sand castings have following mechanical properties: tensile strength, 47,000 psi; yield strength, 38,000 psi; and elongation, 4%. Permanent molds have tensile strength of 53,000 psi; yield strength of 43,000 psi; and elongation of 7%. **Reynolds Metals Co, Richmond 18, Va.**

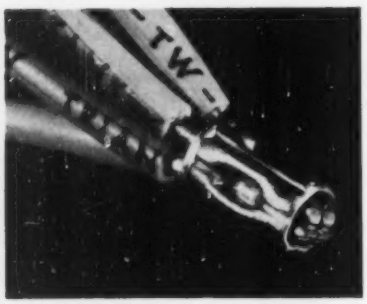
Circle 307 on Reader Service Card



Directional control valve . . .

is indexed by midget rotary actuator. Supplying shop air at 100 psi to the actuator provides sufficient torque to index the four-way valve operating a 2000-psi hydraulic circuit. Reportedly offering low pressure drop and tight seal, valve is available in ¼-, ⅜- and ½-in. pipe sizes. **Sarasota Precision Products Inc, 5757 McIntosh Rd, Sarasota, Fla.**

Circle 308 on Reader Service Card



Splice cap . . .

eliminates wire twisting. Has eight flutes equally spaced around barrel to strengthen cap and help position it in crimping tool. When cap is crimped, wires are flattened and deformed lengthwise for wire-to-wire contact. Untwisted conductors are then confined in a tight area with no voids between them. Nylon insulators that snap on cap provide see-through inspection of completed splices. Caps are listed as "pressure-type wire connectors" and "fixture-type splicing connectors" for 2 #18 through 4 #12's. Insulators are UL and CSA listed for 600 v on building wire and 1000 v in fixtures, in applications up to 221 F. **Buchanan Electrical Products Corp, Hillside, NJ.**

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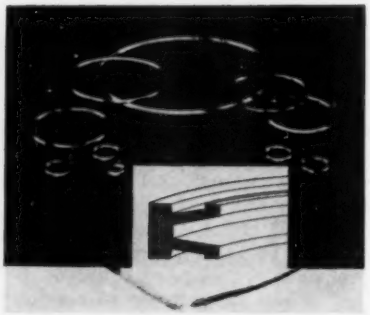


Metallic static-face seals . . .

are said not to leak at temperatures from —450 to 2000 F and pressures to 20,000 psi. Seals liquids and gases in valves, actuators, missile and rocket engines, couplings, filters and in any category where temperature, vibration, pressure and expansion are critical. Made in wide range of materials: Inconel X, age hardened; A-286, age hardened; 17-4PH to H1150 hardening; 7056-T6 aluminum; 18-8 Cres, heat treated; and tantalum, annealed. Most can be plated with silver, gold, indium, Teflon, Kel-F, copper, etc. Seals are lapped for flatness and smoothness of sealing faces and have an integral spacer to closely control groove depth. To instal, seal is indexed to one mating surface and opposite surface is brought against seal. Sealing faces are located at minimal diameter, exposing large area to system pressure. Available in wide size range from miniatures to large diameters. **Haskel Seals Div, Haskel Engineering & Supply Co, 1236 S Central Ave, Glendale 4, Calif.**

Circle 310 on Reader Service Card

Sight-feed valves . . .

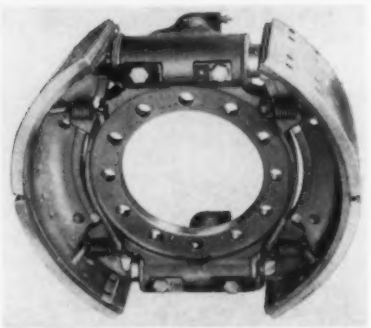
available in single or multiple outlets up to 24, have sediment chambers which trap dirt and grit. Suitable for installation in limited spaces, or for hazardous or hard-to-get-at locations. Each outlet has sight-feed port and independent vibration and leakproof friction needle adjustment which allows feed regulation from steady flow to complete shutoff. All adjustments are made from front with slotted knurled knob. Valves are constructed of solid brass and entire assemblies are electronically silver brazed. Outlets have compressing fittings for ¼-in. OD tubing. **Trico Fuse Mfg Co, 2948 N 5th St, Milwaukee 12.**

Circle 311 on Reader Service Card

Compact valve banks . . .

combine miniature 4-way directional control valves with gasket-mounted cylinder lock valves. Prevent cylinder drift by checking reverse flow. Units' small spool valves also are suitable as pilot valves to remotely operated larger valves. Directional control valves are for systems with 0 to 3000-psi operating pressures. Up to 15 of these valves can be combined into a bank. Banks are available with ⅛ and ¼-in. dry-seal pipe threads and handle oils and noncorrosive fluids. **Sarasota Precision Products Inc, 5757 McIntosh Rd, Sarasota, Fla.**

Circle 312 on Reader Service Card



Hydraulically actuated brake

provides equal braking effort by both shoes and is available in 17-, 20¼-, 22- and 26-in. dia and in 4 to 10-in. widths for wide variety of off-highway operations. Can be actuated by straight-hydraulic, air-over-hydraulic, or vacuum-over-hydraulic action. All actuation parts are internally located and sealed in lubricant. **Brake Div, Rockwell-Standard Corp, Ashtabula, Ohio.**

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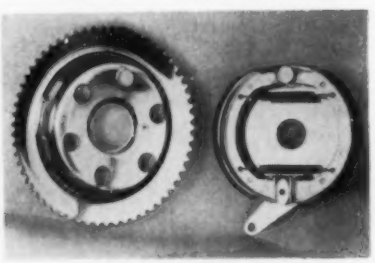


Drum-sprocket brake . . .

originally designed for scooter-type vehicles, is suitable where space is limited between axle-suspension points. Lever actuated, internally expanding brake mechanism is mounted on axle and remains stationary. Five-in. drum and driven sprocket, fabricated in one piece, revolves around brake mechanism. Two sizes of drum-sprockets are available—7.38 and 8.81 in. dia. (entire assembly is 1½ in. thick). Smaller sprocket has 60 teeth and

continued on page 66

CIRCLE 65 ON READER SERVICE CARD→

Application tested! Proved!

WHY HEAT TREAT PARTS? use e.t.d. 150

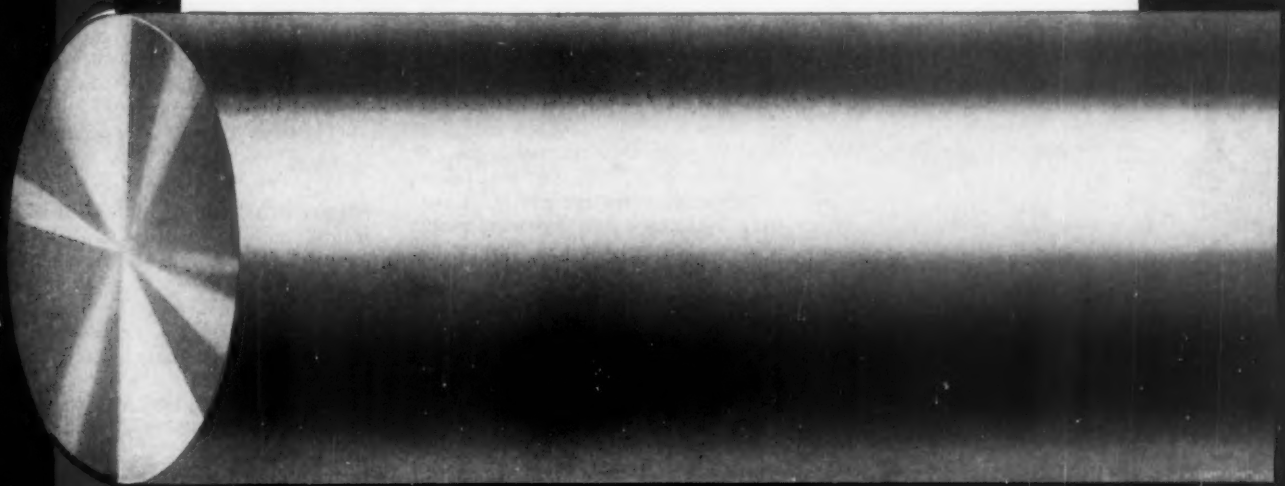
elevated temperature drawing (150,000 psi tensile)

ALLOY STEEL BARS

e.t.d. 150 Alloy needs no heat treating!

e.t.d. 150 Alloy has 150,000 psi tensile guaranteed! (Rockwell C32 minimum)

e.t.d. 150 Alloy machines better than heat treated alloy steels!



Here are cost-reducing advantages

(1) Heat treating problems, costs (and secondary operations) are eliminated. (2) "e.t.d." 150 machines better than heat treated in-the-bar alloy steels. (3) Tool life and finish are excellent. (4) No quench cracks or distortion from heat treatment. (5) "e.t.d." 150 has exceptional strength and hardness uniformity across the bar. (6) End cost of parts is greatly reduced.

Use this coupon to request Helpful Data Bulletin 22.

La Salle STEEL CO.
1430 150th St., Hammond, Ind.

Manufacturers of STRESSPROOF®, FATIGUE-PROOF®, and a complete line of cold-finished steel bars.

Name_____

Title_____

Company_____

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City_____ Zone____ State_____

Available from your Steel Service Center

larger, 72 teeth. Both use No. 35 chain. **Magneto & Engine Accessories Div, Fairbanks, Morse & Co, Beloit, Wis.**

Circle 314 on Reader Service Card

Crimp connector . . .

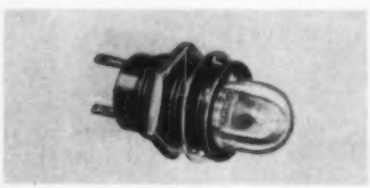
is UL listed for combinations from 1 #14 with 1 #16, up to 1 #6 with 2 #8, making a total of 1028 approved stranded and/or solid wire joints. Also UL and CSA listed for 600-v use in branch circuit and fixture wiring up to 167 F; 1000 v when enclosed in signs or fixtures. Crimp sleeve is cadmium plated steel for max holding power and protection against puncturing. When sleeve is crimped, double indents make contact at right angles to wire so sleeve cannot slide or twist. Requires only pliers with built-in crimping die. After crimping, one-piece polyvinyl chloride insulator is applied for protection all around joint and between wires. **Ideal Industries Inc, 1446 Park Ave, Sycamore, Ill.**

Circle 315 on Reader Service Card

Manual-reset thermostat . . .

is designed so that snap-acting bimetal disk opens contacts when unsafe temperature is reached. Contacts can be reclosed by depressing reset button only after disk cools down and snaps back to original position. Current carrying members are independent of reset button, permitting the device to automatically limit temperature even if reset button is accidentally depressed. UL listed up to 350 F at 25 amp resistive, 120/240 v ac. **Therm-O-Disc Inc, Mansfield, Ohio.**

Circle 316 on Reader Service Card



Indicator lights . . .

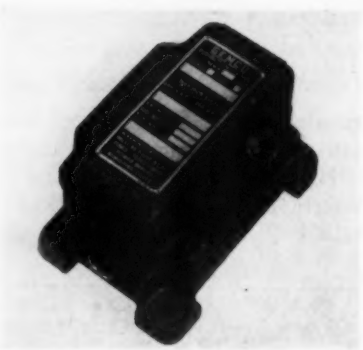
have electrical connections insulated from ground. Ground terminal is welded to shell, and center contact spring is soldered to center contact terminal to eliminate intermittent contact. Two electrotinned solder terminals are locked into position by slots in base to prevent short circuit caused by rotation. One of two mil-standard units is for use with incandescent lamps and is available in eight varieties which use design voltage of from 1 to 28 v, with average life of 30 to 1000 hr. Mounts in $\frac{1}{2}$-in. dia hole, with center to center spacing of $\frac{3}{4}$ in. on panels up to $\frac{5}{32}$ in. thick, projecting only $\frac{41}{64}$ in. behind front of panel. Other type is equipped with built-in 62,000-ohm resistor and takes NE2D neon glow lamps for 115 v current with an average life of about 7500 hr. Also mounts in $\frac{1}{2}$-in. dia hole, on panels up to $\frac{13}{64}$ in. thick and projects only $1\frac{1}{64}$ in. behind front of panel. **Drake Mfg Co, 4626 N Olcott Ave, Chicago 31.**

Circle 317 on Reader Service Card

Electronic temperature controls . . .

have epoxy encapsulated circuitry to protect them from normal shock and vibration. Capable of control within ±0.3 F over entire range, with consistent repeatability achieved through use of Wheatstone bridge principle and wire wound resistance sensing element. Temperature ranges are from —300 to 2000 F, with standard range at 0 to 800 F. Available in 20 models, some with miniature pre-actuated bridge circuit which "anticipates" on a proportioning basis the actual setpoint—either high or low—and actuates the relay. **Electronic Processes Corp, 436 Bryant St, San Francisco 7.**

Circle 318 on Reader Service Card



Toggle-type pushbutton station . . .

for hazardous area service, consists of two sets of contact blocks (housed in an all aluminum enclosure) which are actuated by lever type operator. Maintained 2- or 3-position or momentary 2-position contacts can be provided. Has max of two contacts in either position and any arrangement of normally opened or closed contacts. All contacts are double break with silver-to-silver contact points and carry heavy-duty ratings. **Gemco Electric Co, 25685 W Eight Mile Rd, Detroit 40.**

Circle 319 on Reader Service Card

Explosionproof motors . . .

in ratings of $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 hp, offer variable speeds in ratios up to 10:1. UL approved for service in atmospheres of explosive fumes or dusts. Has hand control assembly with fluted knob that turns with 1/7th the effort of previous controls. Speed drift is prevented by anticreep device. **US Electrical Motors Inc, PO Box 2058 Terminal Annex, Los Angeles 54.**

Circle 320 on Reader Service Card

Miniature induction motor . . .

is totally enclosed 7.5-oz unit with operating speed of 5200 rpm that functions as continuous duty motor when equipped with appropriate blower. Originally designed to operate $2\frac{1}{8}$-in. dia, 4-blade fan in cooling electronic equipment. Ratings include: 1/100 hp; 208 v, 400 cps, 3 phase voltage; 1.87 oz-in. torque at full load; starting torque of 214% of full-load torque; pullout torque, 222% of full-load torque; full-load current of 0.14 amp; and starting current of 0.186 amp. **Kearfott Div, General Precision Inc, 1150 McBride Ave, Little Falls, NJ.**

Circle 321 on Reader Service Card

Fluid transfer . . .

withstands cycling or steady pressures to 1200 psi at rotational speeds to 12,000 rpm. Suitable for gundrill, clutch, power cylinder and similar uses calling for transfer of fluids from stationary source to rotating hollow spindle. **Sealol Inc, Providence, RI.**

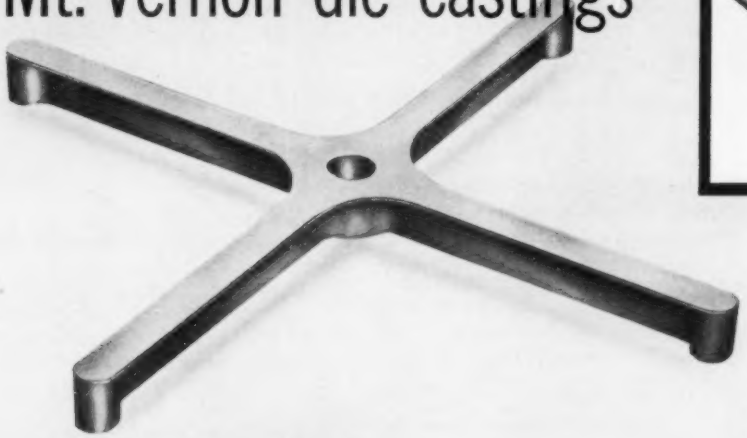
Circle 322 on Reader Service Card

Three-way solenoid valves . . .

with $\frac{1}{4}$-in. main orifices and $\frac{1}{4}$-in. NPTF, are for use in hazardous locations. Available normally open, normally closed and directional control, with operating pressure differentials of 5 to 150 psi. Explosionproof units are UL approved for Class I Group D use in atmospheres of gasoline vapors, etc; for Class II Group F, coal and coke dust; and Group G grain

continued on page 68

Steel furniture manufacturer gets **these 5 benefits** from Mt. Vernon die castings



CASE HISTORIES FROM MT. VERNON FILES

Subject:

Art Steel Company, New York City

In a major switchover, Art Steel Company makes this handsome Steelmaster Desk with aluminum die cast legs. The companion Executive Chair stands on a die cast aluminum base. Formerly it took 8 parts to assemble each island leg of the desk... and 14 parts for the chair base. But switching to die cast parts gave Art Metal Company 5 major benefits:

1. Simpler fabrication since all castings are one-piece integral units. No more multiple section subassembly work.

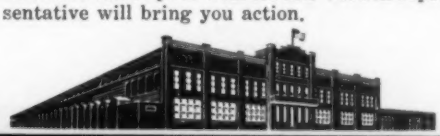
2. Complete freedom in designing due to the many inherent advantages of the die casting process.

3. Corrosion of legs and bases caused by office cleaning detergents no longer a problem. Aluminum die castings stay bright and attractive.

4. Die castings are delivered polished, drilled and tapped, ready for use. Several assembly steps previously required have been eliminated.

5. Because production of legs and bases has been put into Mt. Vernon, valuable production capacity at Art Steel has been freed for other requirements.

More and more, in a great variety of products, Mt. Vernon Die Castings are replacing complex sheet metal assemblies and costly, crude sand castings, bringing significant production economies to the manufacturer. All the knowledge we have gained on this subject is also available to you... free. Why not discuss your problem with us too. A call to your nearest Mt. Vernon representative will bring you action.



MT. VERNON DIE CASTING CORPORATION
STAMFORD, CONNECTICUT

SALES REPRESENTATIVES
BALTIMORE, MD.: Mr. C. M. Gordan, 919 St. Paul St.
BROOKLYN, N. Y.: Mr. Robert V. Moore, 2317 Plumb 2nd St.
CLEVELAND, OHIO: Mr. Grant Eller, 6 East 194th St.
MARIETTA, N. Y.: Mr. Burt J. Meldrum, Olanco Road
PITTSBURGH, PA.: Mr. Andrew W. Anderson, 300 Pasadena Drive So.
STAMFORD, CONN.: Mr. Anker Anderson, Cascade Road
VALLEY FORGE, PA.: Mr. G. T. McMaster, P.O. Box 115

dust. Supplied in wide range of voltages and frequencies with naval forged brass bodies and internal parts of brass and stainless steel. **Skinner Electric Valve Div, Skinner Precision Industries Inc, New Britain, Conn.**

Circle 323 on Reader Service Card

Retracting coiled cords . . .

are available alone or with strain reliefs, special plugs, connectors and other components molded on for communication, power supply and other applications. Custom or stock components comply with UL, CSA, Bureau of Ships, Signal Corps and other standards. **Miller Electric Co, 120 Main St, Pawtucket, RI.**

Circle 324 on Reader Service Card

Miniature valve . . .

for ⅛-in.-OD tubing, has pressure rating of 3000 psi at room temperature. Straight pattern, forged body unit measures 2¼ in. high, permitting use in instrument design. Available in brass and type 316 stainless steel with colored handles for color coding, Teflon cylinder packing and micro-regulating and nonregulating stems. Orifice is 0.080 in. **Whitey Research Tool Co, 5525 Marshall St, Oakland 8, Calif.**

Circle 325 on Reader Service Card

Glow lamps . . .

have starting time of less than 1 millisec in complete darkness as well as in light. Available in three types with breakdown voltages of 104-112, 66-74 and 170-200 v dc; and maintaining voltages of 64-74, 52-59 and 70-75 v dc. **Signalite Inc, Neptune, NJ.**

Circle 326 on Reader Service Card

Snap-action footswitches . . .

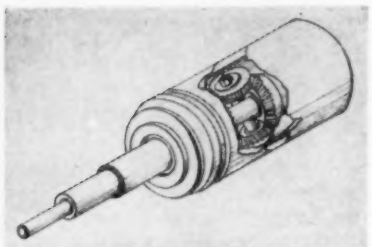
are available in ratchet and reverse-sequence forms. Former is useful where maintained control is needed and has contact mechanism consisting of snap-action switch with one normally open and one normally closed contact. As foot pedal is depressed, contacts are actuated (open contact closes and closed contact opens) and remain in this position until foot pedal is depressed again. Reverse sequence, two-stage footswitch has two snap action switches, each with one normally open and one normally closed contact which operate in reverse sequence to standard two-stage footswitch. When foot pedal is depressed, contacts of one switch will operate before contacts of second switch. Upon release of pedal, contacts in switch that operated first when pedal was depressed will again operate first. On both forms, contact mechanism is enclosed in heavy-duty, water- and oil-tight gasketed NEMA IV enclosure. **General Electric Co, Schenectady 5, NY.**

Circle 327 on Reader Service Card

Rear-projection indicator . . .

contains 12 individual projectors, each producing sharp image centered on single front screen. Uses miniature lamps which can be replaced from rear. Up to three 7-character words can be projected on 0.5 in. high x 0.4 in. wide viewing screen. Entire unit measures ¾ x 1⅛ x 3¾ in. **Tasker Instruments Corp, 7838 Orion Ave, Van Nuys, Calif.**

Circle 328 on Reader Service Card



Enclosed differential . . .

is available in board sizes 5, 8, 11, 15 and 18 and are said to have high-speed rotation, min backlash, low breakway torque and max rotational torque output. Single-end unit, made of stainless steel and aluminum, includes ball bearings throughout. From stock at $140 to $150. **Component Div, Sterling Precision Corp, 5 Sintsink Dr, Port Washington, LI, NY.**

Circle 329 on Reader Service Card

Coaxial latching relay . . .

has positive action provided by magnetic latch assembly and balanced rotary armature held in closed position by magnetic force. Armature stays closed even under severe shock and vibration and requires only 0.040 in. of travel before making contact (short enough stroke for make and break with no lag and proper impedance matching). Relay uses low power and can be operated from 100-mfd capacitor pulse or any other available pulse. Measures 2⅛ x 0.86 x 1½ in. and weighs 5.5 oz. Delivery in 6 to 8 wk. **Electro-Actuators Div, Omega Precision Inc, 757 N Coney Ave, Azusa, Calif.**

Circle 330 on Reader Service Card

Solid-state timing relay . . .

functions without moving parts. Carries 50 amp and automatically shuts off after conducting for 50 millisec. Operates from 12-v-dc source, requires short, positive 17 ±11 v low-energy voltage pulse for triggering and has pickup time of 10 microsec. Said to be highly resistant to shock and vibration. **Inter Mountain Instruments Branch, Curtiss-Wright Corp, Electronics Div, PO Box 8324, Albuquerque, NM.**

Circle 331 on Reader Service Card

Vane-axial blower . . .

operates on 115-v 60-cycle ac, or 115-v dc, delivering 68 cfm air at 1.5 in. static pressure. Weighs 1 lb and measures 3 in. in dia and 3¼ in. long. Mounting is made by clamping to servo rim at either end of unit. Integral propeller shroud and motor housing is black anodized aluminum precision casting. Prototypes from stock. **Globe Industries Inc, 1784 Stanley Ave, Dayton 4, Ohio.**

Circle 332 on Reader Service Card

Fractional-hp motor . . .

measuring 4⅞ in. in dia, reportedly has higher starting and running torques than conventional shaded-pole motor. The 6-pole unit is available with from 1/20 to ¼ hp. **Redmond Co Inc, Owosso, Mich.**

Circle 333 on Reader Service Card

Tiny precision relay . . .

measuring 0.2 x 0.4 x 0.6 in., has 100-milliw sensitivity, yet volume of only 0.048 cu in., or 1/18th the volume of a standard micro-miniature relay. Weight of hermetically sealed unit is 0.1 oz max, compared with average of ½ oz for standard

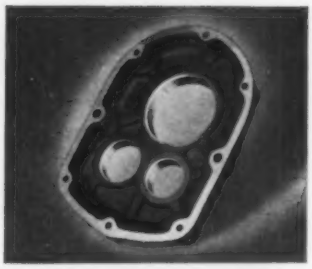
continued on page 70

...the quality-engineered package

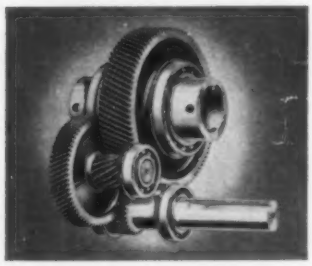
that simplifies speed reduction

DODGE TORQUE-ARM, America's most widely used shaft mounted speed reducer, will save money for *you.* No foundation, no sliding motor base, no flexible coupling, no installation fuss. Developed and perfected by Dodge, this reducer has been so widely accepted in industry that it is now built and stocked in this unmatched range of sizes and models: capacities up to 170 hp; output speeds from 10 to 400 rpm; ratios of 5:1, 15:1, 25:1; speed ratios up to 175 to 1 with correct selection of speed reducer and V-belt drive. Built-in backstop available. Also positive overload release. Vertical models. Flange mounted models. Special application models . . . Go modern—go Torque-Arm! See your Dodge Distributor, or write us.

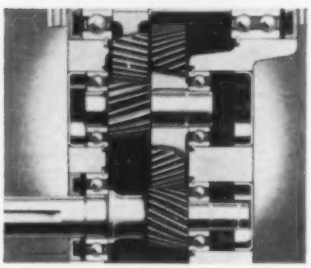
Dodge Manufacturing Corporation, 1200 Union St., Mishawaka, Ind.



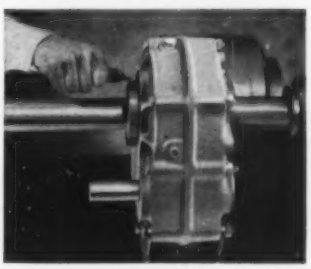
Rugged, semisteel housing holds bearing seats in line for entire life of unit. Laughs at loads. Corrosion resistant.



AGMA rated helical gears. Soft cores withstand shock; hardened surfaces defy wear. Teeth are crown shaved.



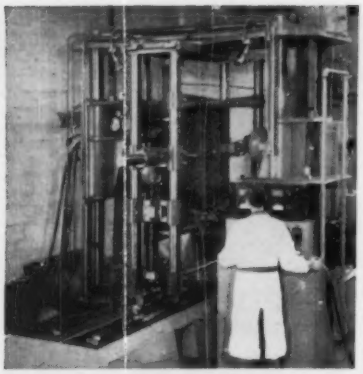
Gears are located *between* bearings and carry their loads without strain. Longer life, higher efficiency.



Unit slides completely onto shaft and locks on *both* sides of housing. This baby stays *put*—runs truer longer.

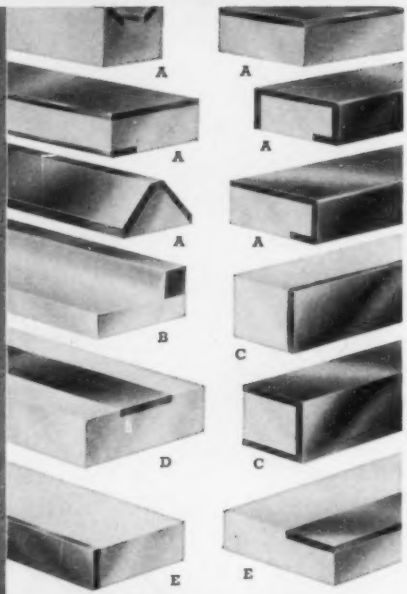
The Products with the Pluses... **DODGE** ***of Mishawaka, Ind.***

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge he can give you valuable assistance on new cost-saving methods.



NEW DRILLING MACHINE PRODUCES MULTIPLE HOLE PATTERNS WITH ABSOLUTE ACCURACY. Built by Walter P. Hill, Inc., Detroit, Mich., this opposed-spindle drilling machine has a flexible automatic system for positioning heads and table for producing hole patterns. To achieve the high degree of accuracy necessary, all components must continually operate on close tolerance. The exposed ways get brutal treatment (falling steel chips, operator walking and standing on them). Hardened ways were selected to run against processed aluminum bronze wear plates, all made by The Ohio Knife Co., Cincinnati, Ohio. These ways are so hard (Rockwell 66 C) as to practically eliminate galling or scoring.

A—Hardened Ways and Slides
B—Composite Die Sections
C—Heel Block
D—Center Clad
E—Flange Slide



save
save
save with
OHIO KNIFE CO.
hardened ways and wear plates

NEW SHAPES—12 cross sections.

NEW USES—for dies, die sections, flange sections, ways, gibs, rails.

88 SIZES—every practical width and height up to 168" length.

65-66 ROCKWELL—to full depth of tool steel along entire length.

READY TO USE—delivered with cutting, forming, wearing surface machined, hardened and ground. Soft steel backing quickly drilled.

LOWER PRICES—production in large quantities enables us to price them below yours or other makes.

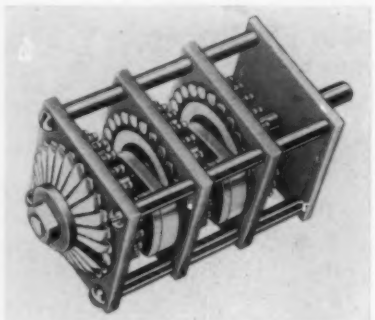
DELIVERY FROM STOCK — to five weeks on all sections including clad aluminum bronze.

For FREE copy of 16-page Bulletin-A, giving complete data on OK ways, etc., write Dept. 123-B

THE OHIO KNIFE CO.
CINCINNATI 23, OHIO

relay. Originally designed for a major intercontinental ballistic missile program, unit is rated at 20 g's to 2000 cps, but has been vibration tested to 45 g's without failure. In shock testing, withstood 100 g's with no failures, no "bounce" and no momentary contact openings. Operates over ambient temperature range of —85 to 257 F at max pull-in current of 7 ma for 2000-ohm coil; 18-30 v rating. Current rating is 0.25 amp with contact life of 100,000 c min at rated resistive load of 28 v dc. The SPDT unit is available in coil resistances of 500, 1000 and 2000 ohm, in ranges of 12, 16 and 18-30 v. **Control Dynamics Corp, North Hollywood, Calif.**

Circle 334 on Reader Service Card



Progressive shorting switches can have 20, 24 or 32 positions, depending upon application. All positions are shorted out except those actually in use. Separate collector ring connection for complete or continuous programing is useful where metering or pertinent information is needed on each position, or where it is not necessary to use one position for pickup service. Switches can be ganged for multiple deck applications. Available sizes are 1¾ in. with 20 and 24 positions and 2¼ in. with 24 and 32 positions. Any lesser combination of figures is available on request. **Daven Co, Livingston, NJ.**

Circle 335 on Reader Service Card

Miniature thermostat . . . incorporating a bimetal actuated contact, is insulated by two glass seal solder terminals. Can be calibrated and hermetically sealed at factory or by user. Max differential is stated at 32.9 F. **Chatham Controls Corp., 159 River Rd, Chatham, NJ.**

Circle 336 on Reader Service Card

Flow transducers . . . have ranges of 0 to 0.5 gpm through 0 to 200 gpm. For telemetry systems, signal conditioning amplifier can be incorporated which will provide 5-v full scale output.

Each unit consists of full bridge system with four active bonded strain-gage sensing elements which sense flow force on a cantilever reed in the flow stream. Sensitivity is 4 mv/v; flow is unidirectional; linearity, 2% of full scale; and repeatibility, less than 0.25%. All movements are cantilever bending. Each measures approx 1¼ x 1 x 4 in. and weighs approx 8 oz. **Standard Controls Inc, 1130 Poplar Pl, Seattle 44.**

Circle 337 on Reader Service Card

Removable-tire wheels . . . available in diameters of 3 through 10 in., have separable side disks that can be demounted to replace tires. Come in choice of wheel bearings—annular adjustable cup and cone or Hyatt type roller bearings. Tire itself is furnished in nonmarking grey, conductive or Neoprene rubber. **Payson-Harris & Reed Inc, 2916 W Jackson Blvd, Chicago 12.**

Circle 338 on Reader Service Card

Transparent tapes in 20 colors and 10 different patterns, are available in 10 widths from 1/32 to 1 in. The self-sticking tapes have write-on, nonreflecting surfaces. When overlayed on maps, drawings, layouts and graphs, they provide color sections without obscuring pertinent detail. **ACS Tapes Inc, 217 California St, Newton 58, Mass.**

Circle 339 on Reader Service Card

Hydraulic drafting table . . . has up-and-down range of nearly 2 ft to accomodate both standing and sitting positions. Angle adjustments range from horizontal to vertical, and board can be rotated freely 360° around base. Low center of gravity permits free placement without floor attachments. Suitable in climate extremes, board has system of vent holes on edges to provide moisture equalization throughout interior of lattice work core. Unit with 40 x 60-in. board is priced at $250. **Isis Inc, Box 1062, York, Penna.**

Circle 340 on Reader Service Card

A few words about Couplers from Earl F. Bruning

Fourteen years ago those of us who were most concerned saw that before the art of hydraulics could fulfill its most extravagant promises, there would have to be found a simpler way of connecting fluid lines. It would have to be a precise way, too, because in handling fuels and liquids in the years ahead, no spillage or air inclusion could be acceptable.

At The Bruning Company, we believe we have a family of quick-disconnect couplers that is definitely superior, exhibiting very low flow resistance and turbulence, and with operating pressures from 6,000 to 10,000 P.S.I. and up.

The Bruning line of couplers is the broadest in the industry. Models can be furnished for nearly any fluid medium, ranging from simple hydraulic fluids to the most exotic liquids and fuels — even under extreme temperature conditions.

Types include self-sealing and open-flow, self-locking and slip-joint, and various models for connecting and disconnecting under pressure.

Because we have become specialists in this field and enjoy a remarkable degree of employee cooperation and enthusiasm, we have been able to price most of our couplers substantially below competitive models.

Please let us know your application specifications so that we can send you a sample Bruning coupler.

THE BRUNING COMPANY

LINCOLN, NEBRASKA

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A NEW SYMBOL
FOR ESTABLISHED
QUALITY PERFORMANCE
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This is the new corporate symbol of Brookside Corporation. It embodies our promise of the same quality performance that has been built into every Brookside fan and blower for the past 14 years. It carries the assurance that *your* product incorporating a Brookside fan will give constant customer satisfaction.

It is also a symbol of *service*—custom engineering at no charge . . . competitive pricing . . . and unfailing delivery, whether you need 2,000 or 200,000 fans in a shipment.

We work hard at *service* and *quality* at Brookside, serving America's top 20 manufacturers plus many other companies. May we consult with you on your next air-moving problem?

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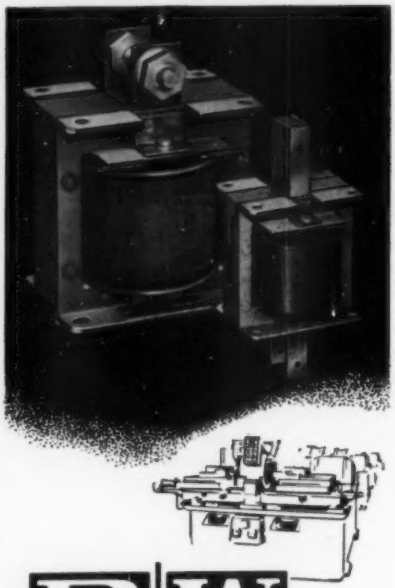
72 CIRCLE 72 ON READER SERVICE CARD

Hi-Powered Personalities
with a compulsive will to work!



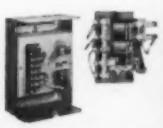
B|W

Alternating Current
SOLENOIDS

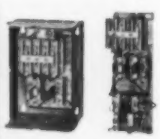
One thing users know about B/W Hi-Power Solenoids is that they seem to thrive on work—and the more the merrier! Whether you want 'em to push or pull, continuously or intermittently, they're always on the job. Take great delight, as a matter of fact, in their ability to convert electrical energy into a constant mechanical force. And that, no doubt, is one good reason why they live so long.

☐ So next time you need solenoids—to control valves, operate brakes, stake parts or do any one of countless other useful, force-full jobs, you'll do well to specify B/W Hi-Power Solenoids.

Other Reliable B/W Electrical Control Components



Induction Type & Electronic Relays



Magnetic Starters & Combination Starters

Custom Engineered Control Panels

Magnetic Contactors, Reversing Contactors

Complete technical data available upon request—write today!

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2200 E. MAPLE ROAD • BIRMINGHAM, MICHIGAN
Manufacturers of Liquid Level and Industrial Motor Controls

CIRCLE 204 ON READER SERVICE CARD

DESIGN LITERATURE

Large-diameter Anti-friction Bearings

H W ANDERSON, H L KNOTTS, J O PREDALE. Kaydon Engineering Corp, Muskegon, Mich. 8 x 11, 227 pp. $25.

Developed by Kaydon's engineering department under a research and development contract from the Massachusetts Institute of Technology, Lincoln Laboratory, this research study (full title: "Feasibility Study of Large Diameter Anti-friction Bearings for Radar Antenna Applications") on large-diameter rolling-element bearings provides a comprehensive reference for bearing designers, designers of radar antennas and other applications using large bearings, and those interested in the art of mechanical engineering.

The study summarizes the present state of the art of large bearing design, including detailed discussion, formulas, and other specific data on all types of ball and roller bearings. It investigates the methods for obtaining bearings having the maximum load-life capacity for support systems such as those needed for very large rotating antenna systems.

Kaydon's study also reviews the art of supporting and rotating large antenna structures of a size and weight beyond present capacities. Included is a facilities survey to establish the size limitations on knowhow and equipment for fabricating, shipping and handling of these huge bearings.

More than 75 graphs, most of which are fold-out double-page size, cover internal load distribution, contact angles, capacity, life, deflection, mean compressive stress, contact ellipse, and other data. Separate sections present a sample problem, derivations from standard formulas used in the study, and a bibliography.

The Explosive Working of Metals

JOHN PEARSON. PB-161828 (NAVORD Report 7033). Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10½, 48 pp. $1.50.

This report covers ten years of high-energy-rate working of metals at the US Naval Ordnance Test Station, China Lake. Academic in its approach, the test program investigated the fundamental aspects of explosive forces, pressures and velocities.

It reports on the physics of the explosive shock waves and how they affect metal properties in such metalworking operations as forming, sizing, shaping, cutting, compacting and welding. Good coverage on earlier work in this field at a low price, but offers no new design information.

Electric Circuits and Machines

EUGENE C LISTER. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6¼ x 9¼, 397 pp. $5.50.

A text intended for students in technical schools and courses as well as engineering undergraduates not specializing in electricity, this third edition has been substantially rewritten in a number of chapters. Chapter headings include such subjects as dc circuits, primary and secondary batteries, magnetism, electromagnetic induction, dc generators, dc motors and controls, single- and three-phase circuits, transformers and regulators, ac generators, polyphase induction motors, switching equipment, electron tubes and devices.

Other Books of Interest

Identification Code for Ball and Roller Bearings

American Standard B54.1-1960. American Standards Association Inc, 10 E 40th St, NY 16. 8½ x 11, 44 pp. $4.

Punched Card Data Processing Annual

A D Meacham, Editor, Gille Associates Inc, 22nd Floor, Book Tower, Detroit 26. 8¾ x 11¼, 259 pp. $15.

Computer guide with articles on billings, sales analysis, inventory control, accounts receivable, payroll and acounts payable.

Dielectrics

Publication 799, National Academy of Sciences—National Research Council, 2101 Constitution Ave, Washington, DC. 8½ x 11, 423 pp. $8.

Digests of literature on dielectrics that appeared in the year 1959. Prepared by Conference on Electrical Insulation, Div Engineering and Industrial Research, National Academy of Sciences—National Research Council.

Semiconductor Abstracts, Vol VI

Battelle Memorial Institute. John Wiley & Sons Inc, 440 Park Ave South, NY 16. 8½ x 11, 528 pp. $14.

Abstracts of literature on semiconducting and luminescent materials for the years 1957-59.

continued on page 75

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Polyvinyl Chloride: Reports on Plastics in the Tropics

British Ministry of Aviation. British Information Services, 45 Rockefeller Plaza, NY 20. 8 x 12¾, 56 pp. $1.16.

Top Management Handbook

H B Maynard, Editor. McGraw-Hill Book Co Inc, 330 W 42nd St, NY 36. 6 x 9¼, 1236 pp. $17.50.

Not a handbook in the usual sense, but rather a collection of articles by 60 executives on the functions, objectives and problems of management.

ABSTRACTS FROM THE LITERATURE

Battery Technology

This paper shows how far electrochemistry and battery technology have progressed in the utilization of the energy of materials.

"The General State of Advancement of Battery Technology," J. J. Lander, Delco-Remy Div, General Motors Corp, Anderson, Ind. Paper No. 269E. SAE International Congress and Exposition of Automotive Engineering, Cobo Hall, Detroit, Jan 9-13, 1961. 485 Lexington Avenue, New York 17.

Measuring Acceleration

Seventeen different ways of measuring acceleration are described and drawings of their mechanisms are included.

"17 Ways to Measure Acceleration," H B Sabin, American Bosch Arma Corp. Control Engineering, Feb '61, 330 W 42nd St, New York 36.

Thermosetting Polymers

The use of thermosetting polymers, often under conditions of high temperature, is rapidly increasing; but information on their thermal stability

continued on page 77

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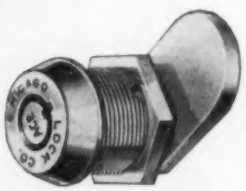

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is very limited. Experimental results of electrothermal analysis are presented, together with conclusions drawn from the analysis.

"Electro-thermal Analysis of Thermosetting Polymers," by R. W. Warfield, Non-Metallic Materials, Div, Chemistry Research Department, US Naval Ordnance Laboratory. Presented at the 17th Annual Technical Conference, SPE, 65 Prospect St, Stamford, Conn.

Milled Surfaces

This first-of-a-series discusses the effects of cutter diameter, number of teeth, runout and feed on the accuracy of milled surfaces.

"Accuracy of Milled Surfaces." Metal Cuttings, Jan '61. National Twist Drill & Tool Co and Winter Brothers Co, Rochester, Mich.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

ELECTRIC-CODE REQUIREMENTS—Booklet, 8 pp. Interprets and clarifies revised code requirements, affecting installation and operation of portable electric tools and equipment, and pictures and discusses grounding devices that satisfy new requirements. Also contains diagrams of construction of grounding terminals and U-shape grounding contacts used in specification-grade grounding devices. Arrow-Hart & Hegeman Electric Co, 103 Hawthorn St, Hartford 6, Conn.

Circle 350 on Reader Service Card

PRESSURE TRANSDUCERS—Brochure, 4 pp. Supplies performance data on six versions for measuring pressures in the ranges of 0-5 to 0-500 psi full scale. Includes photographs, outline drawings and cutaway views of each. Fairchild Controls Corp, 225 Park Ave, Hicksville, LI, NY.

Circle 351 on Reader Service Card

PUMPS AND POWER UNITS—Catalog EJS, 8 pp. Covers sizes, capacities and design features of gear, motorized, piston, and power steering pumps; fluid motors with reduction gearing; flow dividers; general application, automotive and unitized power units, etc. Dimensional photographs are included. John S Barnes Corp, 315 S Madison St, Rockford, Ill.

Circle 352 on Reader Service Card

RIGHT-ANGLE WORM-GEAR MOTORS—Folder F-1971, 6 pp. Ratings and dimensional data are given for both single- and double-reduction types. De-

continued on page 79

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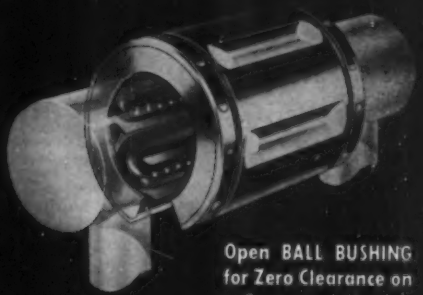

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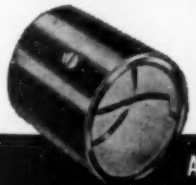

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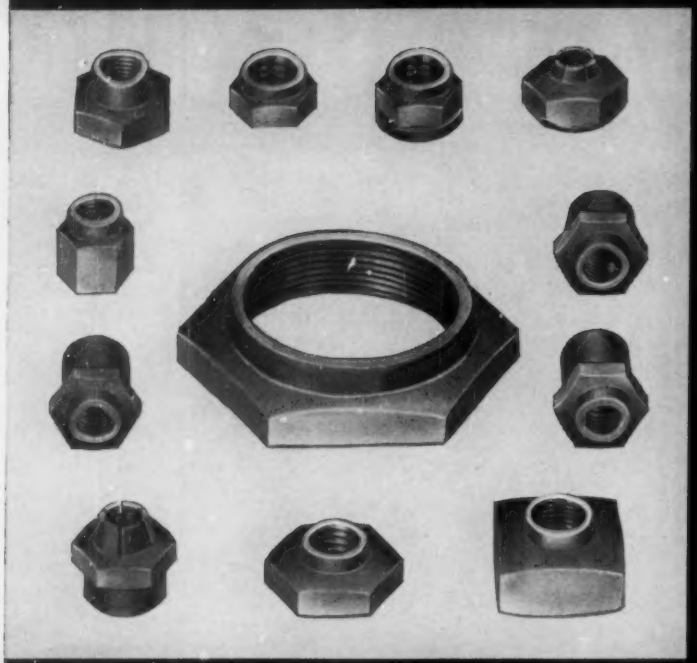

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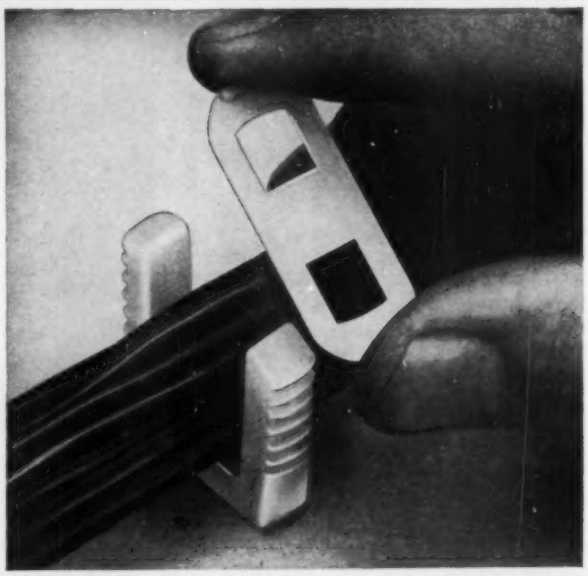

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sign features are illustrated in cutaway drawings. US Electrical Motors Inc, PO Box 2058 Terminal Annex, Los Angeles 54.

Circle 353 on Reader Service Card

CELLULOSIC PLASTICS – Pamphlet, 8 pp. Summarizes and compares chemical resistance and properties of acetate, butyrate and propionate. Discusses and illustrates their range and scope of use. Eastman Chemical Products Inc, Kingsport, Tenn.

Circle 354 on Reader Service Card

PULLEY AND CLUTCH UNITS–Catalog 40, 8 pp. Describes and illustrates general purpose, heavy-duty, special-duty and ball bearing lever action clutches. Outlines optional shaft requirements, pulley sizes, actuating devices, prices and applications. V-Belt Clutch Co, 418 N Western Ave, Los Angeles 4

Circle 355 on Reader Service Card

MANUAL STARTERS–Brochure 10-B1, 8 pp. Contains application suggestions, ratings, prices, photographs and dimensional drawings of single- and two-pole devices for fractional hp motors. Also tabulates heater-coil ratings. Furnas Electric Co, 1000 McKee St, Batavia, Ill.

Circle 356 on Reader Service Card

ALUMINUM INTEGRAL MOTORS–Brochure P-86035-AU, 8 pp. Discusses and illustrates construction features and lists specifications of units available in single-phase and polyphase, from 1 to 7½ hp. Franklin Electric Co Inc, 400 E Spring St, Bluffton, Ind.

Circle 357 on Reader Service Card

DOOR-INTERLOCK SWITCHES–Data sheet 186, 4 pp. Carries photographs, mounting dimension drawings, mechanical characteristics, electrical ratings and prices of three series, including eight standard models. Micro Switch Div, Minneapolis-Honeywell Regulator Co, Freeport, Ill.

Circle 358 on Reader Service Card

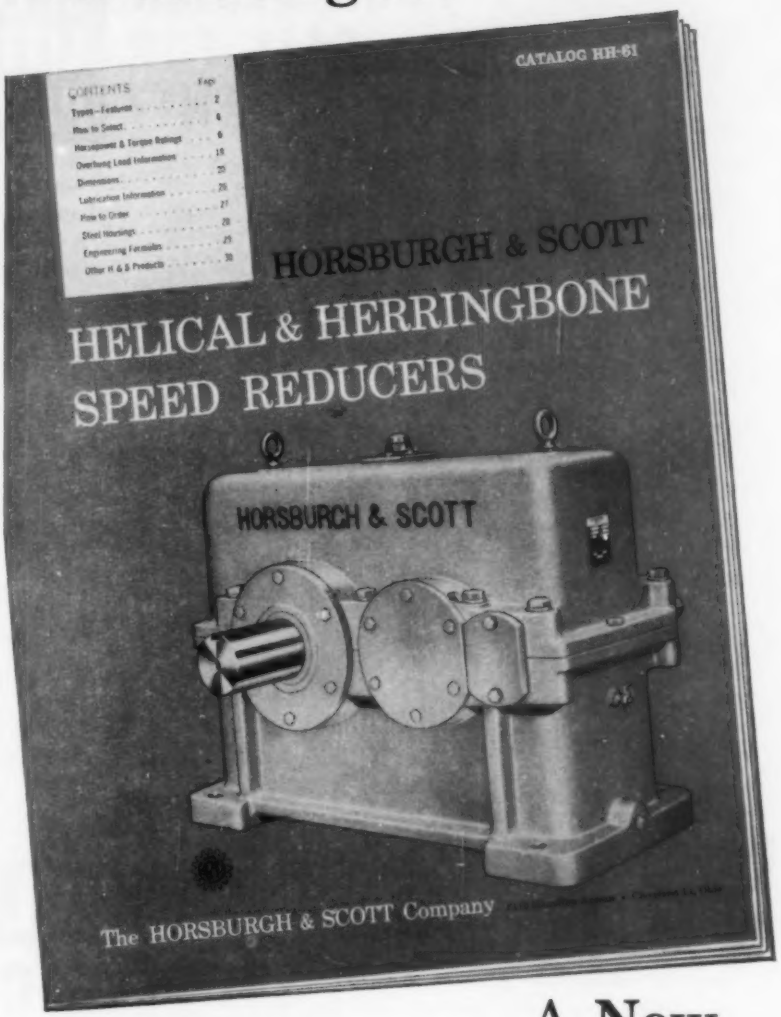
THERMISTOR-TYPE TEMPERATURE CONTROLS–Brochure MC-195, 8 pp. Discusses and illustrates major design features of three models. Also contains electrical and mechanical specifications, available modifications and outline drawings of each. Fenwal Inc, Ashland, Mass.

Circle 359 on Reader Service Card

CLOSE-COUPLED PUMP MOTORS–Bulletin 1455, 4 pp. Explains mechanical variations which make close coupled pump motors and pictures eight single-phase and

continued on page 81

Introducing . . .



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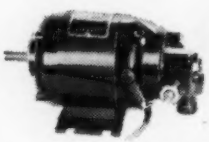

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polyphase models. Dimensions are tabulated. Century Electric Co, 18th & Pine Sts, St Louis 3.

Circle 360 on Reader Service Card

SIGHT-FLOW INDICATORS—Bulletin 18W, 4 pp. Construction details, dimensions and operating limits are given for flapper and rotary types with threaded and flanged connections. Outline drawings are included. Schutte & Koerting Co, Dept M-W, Cornwells Heights, Bucks County, Penna.

Circle 361 on Reader Service Card

O-RINGS—Brochure, 4 pp. Presents physical and chemical properties and price class information, along with photographs of O-ring applications. Stillman Rubber Co, 5811 Marilyn Ave, Culver City, Calif.

Circle 362 on Reader Service Card

VERTICAL MOTORS—Bulletin 1485, 2 pp. Outlines mechanical features and applications for integral-hp verticals. Dimensions are illustrated and tabulated. Century Electric Co, 18th & Pine Sts, St Louis 3.

Circle 363 on Reader Service Card

HARD CEMENTED CARBIDE—Pocket-size booklet, 16 pp. Discusses and illustrates uses for material which has three times the stiffness of hardened steel. Also lists properties. Kennametal Inc, Latrobe, Penna.

Circle 364 on Reader Service Card

FLAME DETECTORS—Bulletin E66-2, 2 pp. Outlines specifications of two types—one which operates an internal relay and another which transmits a signal to a static switch. Design features are listed, illustrated by internal views. Bailey Meter Co, 1050 Ivanhoe Rd, Cleveland 10.

Circle 365 on Reader Service Card

AIR COMPRESSORS—Catalog 123, 8 pp. Pressure range and free-air-consumption tables aid in selecting proper unit. Specifications are outlined for 1- and 2-cylinder, single-stage compressors. Components are pictured. Wayne Pump Co, Fort Wayne, Ind.

Circle 366 on Reader Service Card

SCHEDULING BOARD—Pocket-size booklet, 12 pp. Discusses advantages of customizing board, pressure-sensitive striping tape, and extruded clear plastic to particular visual control needs. Memo Flex Div, 515 Bannock St, Dayton 4, Ohio.

Circle 367 on Reader Service Card

INTERLOCKING-TUBE FILES—Brochure, 6 pp. Describes and illustrates design features of fiberboard tubes for filing rolled documents. Explains how complete filing assembly can be formed by interlocking a number of units. Pack Mfg Co, PO Box 508, Logan, Utah.

Circle 368 on Reader Service Card

LINEAR-MOTION VARIABLE RESISTORS—Bulletin 42-1051, 4 pp. Reviews electrical specifications of six encapsulated and nonencapsulated types. Also tabulates mechanical and environmental inspection and test specifications. Dimensions are illustrated. Electronics Div, Globe-Union Inc, 900 E Keefe Ave, Milwaukee 1.

Circle 369 on Reader Service Card

MINIATURE LOGIC CIRCUITS—Brochure 12211, 4 pp. Contains schematics of 20 AND gates, OR gates, emitter followers and inverters, available in both single and dual circuits. Includes loading table and data on max frequency, output and power requirements. Walkirt Co, 141 W Hazel St, Inglewood, Calif.

Circle 370 on Reader Service Card

IGNITRON EXCITATION CIRCUITS—Bulletin PT-50, 16 pp. Discussion of associated electrode (anode, grid and ignitor) functions is illustrated by schematics, graphs and charts. General Electric Co, Power Tube Dept, Schenectady 5, NY.

Circle 371 on Reader Service Card

INDICATOR LIGHTS—Bulletin, 2 pp. Covers physical and electrical specifications of incandescent and neon units, and includes an outline drawing with mounting dimensions and an electrical connection diagram. Transistor Electronics Corp, 3357 Republic Ave, Minneapolis 25.

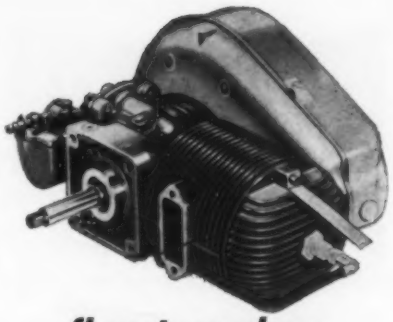
Circle 372 on Reader Service Card

HI-TEMP BOLTS—Bulletin 2717, 4 pp. Details performance of external-wrenching bolt for 1200-F applications. Mechanical properties are covered with tests at room temperatures and at 1200 F and stress relaxation is plotted. Also contains dimensions. Standard Pressed Steel Co, Box 545, Jenkintown, Penna.

Circle 373 on Reader Service Card

FOR MORE CATALOGS AND BULLETINS

. . . 1600 of 'em—see your copy of Product Engineering's Mid-Sep 1960 Design Digest. There you will find helpful design literature, classified under 10 different headings, from important manufacturers and suppliers of components, materials, power and local systems, manufacturing processes.



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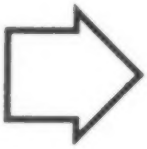

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* DuPont registered trademark
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